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RECENT DEVELOPMENTS IN SOVIET CENTRAL ASIA

DICKSON ASIA LECTURE, 1957

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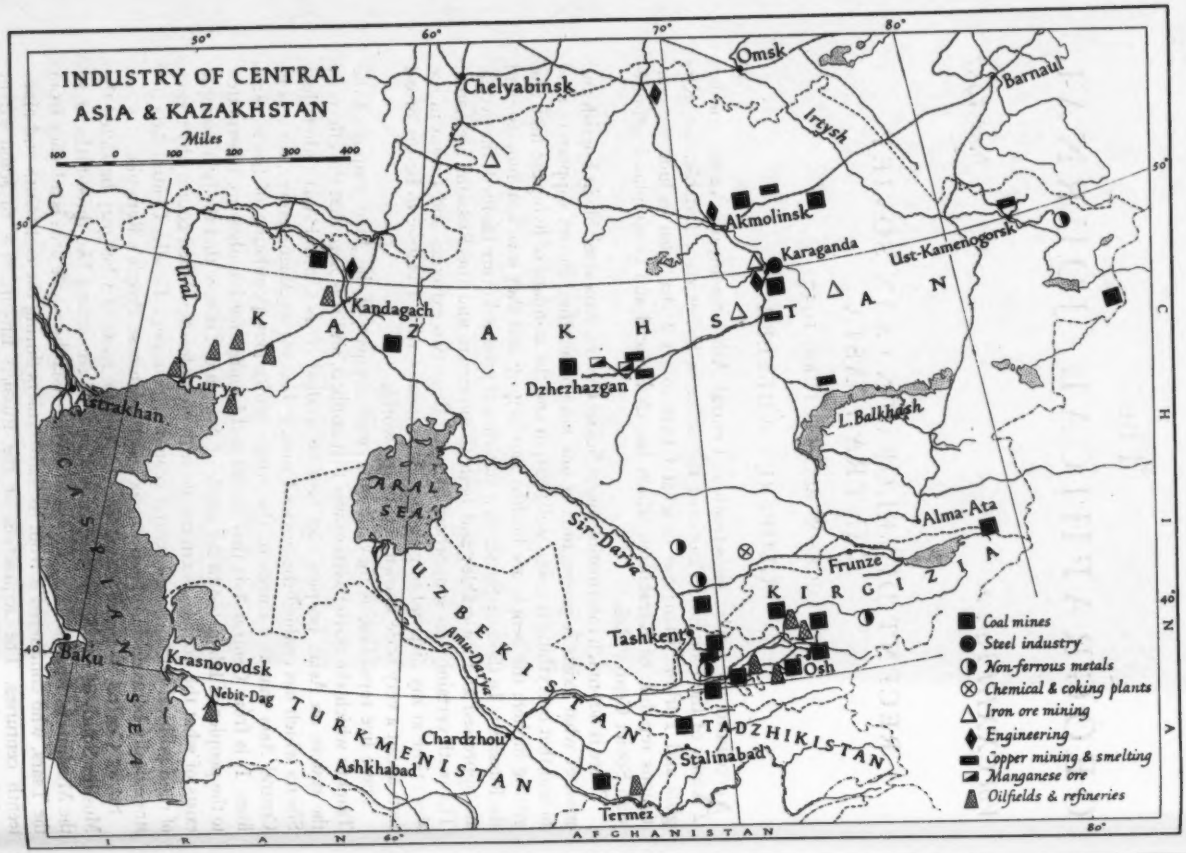
ACCORDING TO Soviet classification, Central Asia—Srednyaya Aziya—consists only of the four Soviet Socialist Republics of Uzbekistan, Tadzhikistan, Kirgizia and Turkmenistan; but in what I have to say I shall also include the contiguous republic of Kazakhstan which has close racial and geographical affinities with Soviet Central Asia.

There is not much information about Soviet Central Asia available in English and most of what exists is propaganda of one kind or another. Soviet supporters tend to find that everything is going well: output and the standard of living are high and getting higher; the people are healthy and happy; and they love Communism and the Russians. In the anti-Soviet view statistics of production are falsified; the people are oppressed and miserable; and both Communism and the Russians are hated. The truth certainly lies somewhere between these two extremes and I want in the short time at my disposal to give you some idea of what I believe to be the broad facts about a very little known part of the world.

These five republics, as they are now, were the part of the Asian empire of the Tsars to which the Soviet system was first applied, and it is here that the effects of the system on Asian peoples may best be studied. It is Central Asia rather than Siberia which has enabled the Soviet Union to become an Asiatic power, for it is in Central Asia that two-thirds of the whole indigenous population of Soviet Asia lives. It is from Central Asia that Soviet and Communist impulses are transmitted to the peoples of Islam and to the whole of Asia, and it is here that the best example exists of what the Soviet system can do with an under-developed country by means of rigid political doctrine and central economic planning. Finally, Central Asia lies strategically between European Russia and the Chinese People's Republic.

Soviet Central Asia and Kazakhstan constitute most of what may be called the Muslim South of the Soviet Union, and contain something like three-fifths of all the Muslims in Russia. Like the rest of Soviet Asia the whole area is a legacy from the Tsars, who conquered it from its native rulers during the eighteenth and nineteenth centuries. The acquisition of the Russian Empire was to some extent accidental and arose out of trading operations which eventually required protection from marauders. In this respect it resembled the British Empire, but there is one great difference: the British was and is an overseas empire and those who acquired


INDUSTRY OF CENTRAL ASIA & KAZAKHSTAN
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ARAL SEA
Sir-Darya
Alma-Ata
Frunze
KIRGIZIA
CASPIAN SEA
UZBEKISTAN
Amu-Darya
Tashkent
Osh
Baku
Krasnovodsk
Nebit-Dag
TURKMENISTAN
Chardzhou
Ashkhabad
TADZHIKISTAN
Stalinabad
Termez
IRAN
AFGHANISTAN
CHINA
Coal mines
Steel industry
Non-ferrous metals
Chemical & coking plants
Iron ore mining
Engineering
Copper mining & smelting
Manganese ore
Oilfields & refineries

it were cut off from their homeland by many thousands of miles of ocean. The Russian Empire, on the other hand, was an overland empire which was not abruptly distinguished from Western Russia in climate and vegetation. This fact is of great importance when comparing British and Russian problems of colonization and exploitation. The Russians, who had expanded due east along the line of least resistance from the Urals to the Pacific during the sixteenth and seventeenth centuries, later turned south and eventually established themselves on the Chinese, Afghan and Persian frontiers. But the conquest was not completed until the battle of Gök Tepe in 1881, only thirty-three years before the outbreak of the First World War.

During the period of Tsarist rule in Central Asia not very much was done in the way of development. A few strategic roads and railways were built; the cotton industry was established and made some progress; and a certain amount of mining of copper and coal was undertaken. Beyond giving them peace and security, not much was done for the people, and the percentage of literacy at the time of the Revolution was probably not more than 2 or 3 per cent. On the other hand, the Russians interfered very little with established tradition: the people were allowed to pursue their own way of life; and they probably enjoyed just as much civic freedom as the people of Western Russia—in some respects even more, for they were not subject to any kind of conscription until 1916 when a limited number were conscripted for non-combatant service. The question of self-government being eventually granted to the various peoples of Central Asia never arose in Tsarist times.

The inheritance of a large empire sparsely inhabited by relatively backward people was at first something of an embarrassment to the Soviet regime, for the whole concept of Empire ran counter to Communism. At first, indeed, there was some idea of creating a kind of loose Muslim federation which would eventually, it was hoped, embrace the neighbouring Muslim peoples of Afghanistan, Persia and Turkey. Various considerations, including the deep-seated notion that the vast area from the Urals to the Pacific was not merely an empire but part of Russian territory, caused this project to be abandoned and the Soviet authorities busied themselves with a practical plan for the administration of the area. A solution was found in the "nationalities" policy, which consisted in labelling the principal races and in demarcating national frontiers on the broad basis of language. This operation was carried out in 1924, and the inter-republican frontiers then aligned have been subjected to only very slight modification since. The frontiers with China, Afghanistan and Persia are precisely the same as they were before the Revolution.

I propose to divide my description of recent developments in Central Asia into three parts—political, economic and cultural.

Let us first consider political developments. There is no time to give you any detailed description of the events of the Civil War, of how the semi-independent states of Bukhara and Khiva were overrun, of how resistance by successive opponents of the Soviet regime—the Social Democrats, Mensheviks, and what the Communists call "bourgeois nationalists"—was eventually overcome.[1] Most of the fighting during the Civil War was not among the native peoples but among warring non-native factions. Soviet propagandists make great play with so-called British intervention although this was merely directed at thwarting a possible German advance after the collapse of the Russian armies in 1917.[2] Suffice it to say that resistance was overcome and Soviet power reigned supreme. Once the Republics were established, all previous systems of administration, whether of the Tsarist or

traditional pattern, were quickly removed and the standard administrative fabric found in all Soviet Socialist Republics was set up. Briefly, this consists in the division of the Republics into *oblasts* and *rayons*—*i.e.* provinces and counties—each under their governing soviets. The Republican Government has a Council of Ministers, most of whom are natives, except the Minister of State Security who is invariably a non-native. Apart from, and much more important than, this is the Communist Party, the First or Second Secretary of which is always a non-native, usually a Russian. In one Republic, Kazakhstan, both First and Second Secretaries have for some time been Russians. Under the Constitution, a great deal of administrative authority rests in Moscow.[3] How far these Republics are really self-governing it is difficult to say. Perhaps they are as much so as Poland was until a short while ago, that is to say, by non-Communist standards they are not self-governing at all. On the other hand, it must be realized that in Central Asia there is no tradition of independence. None of the peoples have ever known real independence except during brief troubled periods immediately after the Revolution. Most of them have never even seen independence in operation. Moreover, as a result of intensive Soviet propaganda, they are probably convinced that they are not only better off but much more independent than their co-religionists in Afghanistan and Persia, who are still supposed to be "groaning under the colonial yoke." Very few of them know that, whatever Western influence there may be in these countries, it does not involve large-scale white colonization of the kind to which they are accustomed in Central Asia. I might mention here that, whereas according to Soviet censuses the native population of Central Asia increased by approximately 5 per cent. between 1926 and 1939, the settler population for the same period increased by over 72 per cent.[4]

In spite, however, of the obviously unrepresentative and undemocratic nature of administration in Central Asia, government is by no means inefficient, nor is it now physically oppressive. Various alternative systems have been suggested: an independent "Turkestan" embracing all the Turkic peoples of Central Asia; or a series of genuinely independent countries based on nationality. The latter might eventually be a practical proposition, but the sudden removal of a paramount power often has unsatisfactory results. The collapse of Ottoman rule in the Middle East seems to be a case in point.

One of the principal objects of Soviet political attack both inside and outside the Union has until quite recently been "bourgeois nationalism." The last serious manifestation of this was in Uzbekistan between 1937 and 1939, when the two leading national figures, Khodzhayev and Ikramov, were executed and a general purge of nationalists took place.[5] Until quite recently almost every kind of political and social misdemeanour such as "cosmopolitanism," "formalism" and attachment to feudal survivals has been attributed to "bourgeois nationalism." During 1955 the attitude towards "bourgeois nationalist" governments and leaders in countries outside the USSR began to change and since the Twentieth Party Congress of February 1956 it has been clearly stated that the notion held by many Soviet writers that the "bourgeois nationalists" were necessarily the enemies of the proletariat and the "faithful allies of imperialism" is mistaken.[6] This change will hardly apply internally, since there are no "bourgeois nationalists" left who wield any authority or would be worth cultivating from the Soviet point of view.

Perhaps the most startling changes which have taken place in Central Asia are in its economy. In Tsarist times this was almost entirely agricultural, no more than a few thousand people being employed in industry. Today Central Asia is not only

self-supporting in most respects (iron, rubber and heavy machinery—including vehicles—are the main deficiencies) but it makes considerable contributions to All-Union economy. Of these cotton is by far the most important, since over 80 per cent. of the cotton grown in the USSR comes from Central Asia. Since the Revolution agriculture has been collectivized and to a large extent mechanized, and has otherwise changed its character in many respects. For instance, large areas which were previously given over to cereals required for the people's immediate needs have now been converted to the cultivation of cotton. A number of crops, such as maize, beet and hemp previously unknown in Central Asia, have been successfully introduced. According to Soviet accounts, of which there is no reason to doubt the accuracy, output in most branches of agriculture, except livestock breeding, has enormously increased. Stock breeding, which is mostly confined to Kazakhstan and Kirgizia, has, however, declined although recently it has shown signs of picking up. As might have been expected, the utilization of water resources has been greatly developed. There is the great Fergana Canal completed during the last war, and a host of other projects such as those of the Kara-Kum[7] and the Vakhsh River.[8] All these have greatly increased the fertility of the land. One vast project, the main Turkmen Canal, which was to have connected the lower reaches of the Amu-Dar'ya (the old Oxus) with the Caspian Sea, was started with great acclamation in 1947. It was to have been completed in 1957 but was abandoned in 1953 without any reason being given.[9]

In 1954 the so-called virgin lands campaign was launched in Kazakhstan and it is still in progress. It is difficult to speak of the success of this venture with any precision but there is good reason to believe that it is considerable. There have of course been many mistakes and a great deal of waste, but the fact remains that a vast new area has been put under cultivation and a careful examination of available reports suggests that the output has been well up to expectation. Quite apart from this, it has drawn off a large part of the surplus man-power from the western parts of the Union. Exact figures of the new settlement are lacking but the total can hardly be less than half a million and is not yet complete.

The development of industry has been even more striking than that of agriculture. Heavy industries now include coal, oil, copper, steel and the manufacture of agricultural and textile machinery. The last-named industry is of particular interest since it not only provides most of Central Asia's requirements, except in respect of tractors, but even exports machinery to other parts of the Soviet Union and to Eastern Europe. There are also a number of light industries in all the large towns, some of which, such as fruit and fish canning, appear to be very profitable. The proportions of people employed in industry and agriculture have completely changed and in some Republics more people, and particularly women, are employed in industry than in agriculture. The proportion of natives to non-natives employed in skilled jobs is difficult to determine. It may not yet be very high but at the same time the progress made in the technical training of supposedly backward people has been remarkable. Refugees say that the highest forms of technical training such as the piloting of aircraft and the use of machine tools and precision instruments are not open to natives, and quite recently there have been similar complaints in the Central Asian press.

Soviet statistics of wages, output, revenue and taxation are notoriously difficult to follow and it is often said that the Central Asian Republics are mulcted of their resources for the benefit of other parts of the Union. It is impossible to prove or disprove this. It is, however, worth while considering what has recently come to

light with regard to the economies of Poland and Hungary. There now seems little doubt that Poland was obliged to part with a large proportion of her coal output to the Soviet Union at prices far below what could have been obtained from Western Europe. The same may well be true of the valuable cotton industry of Central Asia.

It is not easy to form any conclusion about the standard of living in Soviet Central Asia either from the reports of travellers or the accounts appearing in Soviet publications. Before the Revolution the standard of living and all public amenities seems to have varied from abundance of all the needs of life in a patriarchal society of arcadian simplicity to near starvation level in the deserts and in the mountain regions of the Pamirs and the Tien Shan. There is now little abundance and little, if any, arcadian simplicity, but generally speaking I should say that the standard of living was much the same in Central Asia as elsewhere in the Soviet Union, and on an average a good deal better than in the adjacent countries of the Middle East and South Asia. A lack of amenities and even of the ordinary necessities of life, other than food, is still often reported in the press and there is evidently a great shortage of luxuries except in the large towns.

Bold as are the changes which the Soviet regime has wrought in political and economic life, they are less ambitious and less difficult of attainment than the changes which they are trying to introduce into the traditional cultures of the peoples of Central Asia. Except in parts of Kazakhstan and Kirgizia the culture of Central Asia is Islamic and the Communist Party holds that the Muslim way of life is incompatible with modern materialism and "progress."[10] Soviet cultural policy is therefore directed towards eradicating Muslim culture and substituting for it Soviet, or as often as not, Russian culture. The means they employ include strictly secular education, linguistic reforms, social propaganda, manipulation of the arts and the rewriting of history. At the same time, "national," that is pre-Islamic, culture is to some extent fostered.

The progress in education is remarkable. In the absence of any precise statistics it can be assumed that the proportion of literacy before the Revolution was not more than 2 or 3 per cent. Soviet publicists now claim 96 per cent. literacy, by which they mean that 96 per cent. of the population have finished the Fourth Class in the Middle School. This is perhaps an exaggeration and in any case includes the 6 or 7 million white settlers. But the number of effective native literates, that is, people who can make something of newspapers, of which there are an incredible number in Central Asia, and write to a limited extent, is probably not less than 50 per cent. By comparison with India, Pakistan, Afghanistan and Persia, where the percentage of literacy is nowhere more than 20 per cent. and often very much less, it is a remarkable achievement. Education cannot be called liberal. Religious instruction of any kind is excluded, and there is a strong emphasis on Russian history, literature and language; but judging from the school books which I have examined, there is very little political indoctrination in the Middle Schools. Except in Russian subjects, by the way, the medium of instruction is in native languages. In the technical institutes, *tekhnikums* and universities, however, the medium is generally Russian. A good knowledge of Russian is essential for professional advancement.

Soviet linguistic policy is a matter to which the authorities attach great importance but to which the West has unfortunately paid little attention. Nor is its significance understood in areas of potential Soviet expansion like the Middle East. Great progress has been made in elaborating and systematizing the languages of Central Asia and in working out literary forms for languages which previously had scarcely been written at all. In the process Soviet scholars aim at making all these

languages as much like Russian as possible and to this end have compulsorily introduced the Cyrillic script, a large number of Russian loan-words and various rules designed to Russianize their grammar, syntax and even phonetics.[11] Large numbers of school-books, grammars and dictionaries have been printed which bear evidence of untiring effort and great scholarship. It is not easy to say what effect this policy has had. Turkic peoples are particularly tenacious of their spoken tongues and these do not seem so far to have been much affected. Even the effect on the written languages may prove to be superficial and ephemeral. In any event, most advanced reading and study is done in Russian. The eventual outcome of the policy of Russianization might well be the abandonment of native languages as the medium of instruction in the Middle School.

Soviet anti-Islamic propaganda has passed through several vicissitudes. In the early stages of the regime it was blatant and blasphemous, ridiculing the whole conception of God and the Prophet. Later, direct attacks on Islamic belief were largely discontinued and ridicule was confined to such practices and traditions as were supposed to interfere with progress and productivity. Atheistic propaganda became "scientific."[12] Since 1954 there has been some further modification, presumably to avoid compromising Soviet cultural penetration of the Middle East. I think it is untrue to say that Islam is at present persecuted or suppressed. There has, for instance, been no legislation against practices like the seclusion of women, the observance of certain festivals and the wearing of traditional clothes as there has in some independent Muslim countries. These practices are ridiculed and strongly discouraged, but reports of victimization are difficult to substantiate.

Sustained efforts are being made to remould the arts on Soviet and Russian lines. The drama and opera, previously unknown in Central Asia, have been greatly developed, almost exclusively on Russian models and using Russian and Western themes.

In literature the Russian aim is to create, in local languages, literatures which reflect the lives and cultures of the various Central Asian peoples but which conform to a standard Soviet, and usually Russian, pattern in subject matter, spirit and in style. Traditional forms of literature, which consist principally of poetry and include such bourgeois themes as nightingales, roses and beautiful maidens, are discouraged and the novel, a form of literature quite foreign to native tradition, is greatly preferred as a medium.[13] Recommended themes are life in industry and on the collective farms, the wickedness and murderous proclivities of the British [14] and the great love which the people of Central Asia have always had for the Russians since they were first conquered by them in the nineteenth century. This is not intended as sarcasm: it is a statement of fact which can easily be proved by reference to Soviet publications. But the task of the budding Central Asian novelist is gravely complicated by the frequent changes of directive and criticism. For instance, a well-known Turkmen writer, Ata Kaushutov, thinking, no doubt, that he was on the right lines, introduced into one of his stories a Russian officer who loved the Turkmens so much that he even discarded his Russian name and preferred to sing Turkmen rather than Russian songs. He acquired a swarthy complexion and a scar from a boil caused by the infected bite of a mosquito and very common among Turkmens. But the author was strongly criticized for this and told to write on quite different lines.[15]

The writing and rewriting of history form an important part of Soviet cultural policy. The original Soviet attitude towards Central Asian history was that expounded by Pokrovskiy. He had described the incorporation in the Tsarist empire

of adjacent non-Russian peoples as an "absolute evil" (*absolyutnoye zlo*). In 1937 this notion was abandoned and a decree was published which laid down among other things that the term "absolute evil" was inappropriate in view of the collateral benefits conferred on the incorporated peoples by their association with the superior culture of the Russian people. Thenceforward, the so-called "doctrine of the lesser evil" was propagated. This was based on the theory that the lot of the Central Asians would have been much worse if the Russians had never appeared and had left them to the mercy of the British or Germans. The idea of Russian superiority was greatly fostered during the war and in 1951 it developed into the notion that any use of the word "evil" was inappropriate since the results of the Russian conquest were, on balance, "good."[16] At this time there was a tendency to abandon the word "conquest" (*zavoyevaniye*) altogether and to substitute the expression "voluntary union." Historians who spoke of "conquest" and "colonization" by the Russians were strongly condemned. During 1955 articles began to appear which even went so far as to praise Russian pre-Revolution administration, and attacks on feudal and nomadic society were intensified. Quite recently—September last year, in fact—there has been another change. Writers who devote too much attention to the benefits of Russian influence are now being criticized and they are called upon to examine more closely the inherent national genius of the various peoples of Central Asia.[17] The confusion which these constant changes produce in the minds of Central Asian intellectuals must be considerable. Some famous rebels against Russian authority were first extolled by Pokrovskiy, then found to be obnoxious characters and are now being built up into progressive national reformers. The Caucasian rebel Shamil has already gone through all these phases and the redoubtable Kazakh rebel Kenesary Kasymov, who in 1943 was officially described as "a hero of the Kazakh people" and in 1953 as "an obnoxious character," now seems about to be reinstated. It is probable that this recent development was part of the policy of de-Stalinization and was evidently designed to flatter national sentiment. If de-Stalinization proves short-lived then these national heroes will quickly become obnoxious again.

In Central Asia an experiment in developing the productivity of an under-developed region is being conducted by the Soviet Government in circumstances quite different from those attending similar experiments conducted by the West elsewhere. To begin with, Moscow exercises complete political control over the peoples of the five Republics. The system of civil administration is identical with that applied in the rest of the Union, that is to say it takes no account of traditional methods of government. In spite of the clause in the Constitution which allows the Republics to secede from the Union, no serious person believes that this could happen. The situation is in fact in no way similar to that prevailing even in the satellite countries of Eastern Europe. The peoples of Central Asia have, unfortunately, no tradition of freedom and they are far removed from Turkey, the country with which they have the strongest racial and cultural affinities. There is therefore no overt organized opposition to the Soviet regime and it is difficult to see how this could develop without some relaxation on the part of the central government.

The region's productivity has been greatly stepped-up during the Soviet regime. With the exception of Turkey, no other region which was in a comparable state of under-development forty years ago has made such spectacular advances. In addition, the great increase in literacy is a notable achievement which has not been equalled elsewhere. Indeed, it would not be unfair to say that the Soviet experiment in

Central Asia is a good example of what a deliberate and determined policy of colonialism can achieve. From the point of view of standard of living, general and technical education, and security from famine and invasion, the native peoples of Central Asia are better off than they have ever been before and than the peoples of most of the neighbouring countries. But while all this is a tribute to Russian dynamism and skill, it has been achieved without any advance on what may be called the spiritual side. In spite of the constant talk of nationalities, national culture and national this and that, the republics of Central Asia are not nations in the accepted sense of the word. They have no representation abroad, play no part in foreign policy and have no national armies; and they are subjected to systematic cultural regimentation. Moreover, a careful analysis of population statistics published since the 1926 census shows that the increase in the settler population is out of all proportion to the increase in the native population. There is no doubt that the presence of large numbers of white settlers can speed up the beneficial processes of industrialization, mechanization and modernization of every kind. But, given the choice, even the most backward people would sooner work out their own salvation than be overrun with foreign colonists. The people of Central Asia have not yet been given the choice, nor is there at present any sign that they ever will be.

Remote as the possibility of a breakaway from Soviet control may be, there is evidence to show that the Russians themselves believe that such a possibility exists. To avert it and to obtain more willing cooperation in the stepping-up of production, with the rate of which they are far from satisfied, the Russians might be impelled to grant, or at any rate hold out some prospect of, a measure of genuine self-government. There are two other considerations which may affect future Soviet policy in Central Asia: one is the extent to which they intend to use the Muslim fringe of the Soviet Union in their plans for the penetration of the Middle East and South Asia; and the other is the attitude of China. Asia for the Asians is still an important principle with the Chinese. However close may be the bonds of Communism, the Chinese still regard the Russians as exotic Westerners, and the continued Russian control of Central Asia must be highly distasteful to them.

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[4] *Central Asian Review*, 3, 2 (1955) pp. 89–94.

[5] An objective and valuable account of these events can be found in 'Turkestan im XX Jahrhundert,' by Baymirza Hayit, Darmstadt, 1955.

[6] *Sovetskoye Vostokovedeniye*, No. 1, 1956, Editorial.

[7] *CAR*, 2, 3 (1954), pp. 255–62.

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[9] *CAR*, 2, 3 (1954), pp. 279–81.

[10] See 'Ocherki Istorii Izucheniya Islama v SSSR' ('Outline of the history of Islamic studies in the USSR'), by N. A. Smirnov, Moscow, 1954, and 'Islam and Russia,' issued by Central Asian Research Centre, 1956.

[11] *Voprosy Yazykoznaniya*, June 1952. Article by N. A. Baskakov, translated in 'Turkic languages of Central Asia: Problems of planned culture contact.' Issued by Central Asian Research Centre, London, 1954.

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[15] *CAR*, 1, 3 (1953), pp. 64–72. "Cultural Developments in Turkmenistan."
[16] *Voprosy Istorii*, April 1951. Letter from Professor M. V. Nechkina. Also *CAR*, 1, 3 (1953), article "Central Asia and the Russian People."
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DISCUSSION

Evening Meeting, 28 January 1957

Before the paper the PRESIDENT (General Sir JAMES MARSHALL-CORNWALL) said: Sixty-eight years ago, when I was a very small boy, a most interesting paper on the Trans-Caspian Railway was read at an evening meeting of the Royal Geographical Society by the Honourable George Curzon, who twenty-two years later as Lord Curzon became the Society's President. George Curzon was one of the first Englishmen to travel over 900 miles of that then recently constructed railway from the terminal point on the eastern shore of the Caspian, eastward across the Kara Kum desert, past the oasis of Merv and on across the Oxus to Bukhara and Samarkand. The construction of that railway represented a great engineering feat by the Russian General Annenkoff. The railway was completed in under two years and it formed a link by which the Russians were able to maintain an army of occupation in Central Asia within striking distance of the frontiers of Persia, Afghanistan, India and Tibet. There was considerable perturbation, alarm and despondency in Britain and in India as to the possible effects of that line of communication.

George Curzon, whose address was delivered to the Society in March 1889, expanded that address in the same year into an interesting book 'Russia in Central Asia.' He held quite an objective point of view in regard to the Russian menace in Central Asia, and I would like to quote the preface in which he dedicated that book, because it has a bearing on the lecture we are to hear this evening: "To the great army of Russophobes who mislead others and Russophils whom others mislead I dedicate this book which will be found equally disrespectful to the ignoble terrors of the one and the perverse complacency of the other." Our lecturer will approach the theme from the same standpoint.

Colonel Wheeler will be giving the Dickson Asia Lecture for 1957. Some years ago the late Mr. P. L. Dickson of Singapore endowed the Royal Geographical Society with a fund which the Society has since devoted to a biennial lecture on subjects connected with Asia. This year we could have found no better exponent of the knowledge of Central Asia than Colonel Geoffrey Wheeler. He is Director of the Central Asian Research Centre which, in conjunction with the Soviet Affairs Group of St. Antony's College, Oxford, has the task of piecing together all the published evidence which derives from behind the Iron Curtain. We can no longer as in the past travel through Central Asia as and when we like, as so many adventurous Britons did; for instance, Captain Frederick Burnaby who rode to Khiva in 1874, or whenever it was. In these days we have to get our knowledge of the area by means of published information which happens to reach us from behind the scenes. Colonel Wheeler is a past-master at piecing together documentary evidence, and I feel that I can assure you that what he tells us will neither inspire us with "ignoble terrors" or lull us with "perverse complacency."

Colonel Wheeler then read his paper

The PRESIDENT: I do not myself feel competent to make any comments on Colonel Wheeler's most instructive talk. At any rate, I was glad to observe, and I am sure you shared my pleasure, that the ladies of Turkmenistan do not neglect the subject of geography. Tonight we have as a guest of the Society Brigadier Davidson-Houston,

British Military Attaché in Moscow. Having been a Military Attaché myself, I am fully aware that Military Attachés, like all good little boys, should be seen and not heard. However, I understand that Brigadier Davidson-Houston has the permission of the War Office to give us some unclassified information. I do not quite know what "unclassified information" means; the phrase did not exist in the long-ago days when I served in the Army. I imagine it is one of those expressions, like "top secret," which the War Office has borrowed from the Pentagon. At any rate, I invite, on your behalf, Brigadier Davidson-Houston to make a few "unclassified" remarks.

Brigadier DAVIDSON-HOUSTON: I fear the few remarks I have to make cannot compare in interest with those made by the lecturer but, having been privileged to travel recently in Soviet Central Asia, a few of my personal observations may prove of some slight interest.

Last winter I was given permission to travel to Alma-Ata, the capital of Kazakhstan, and on to Tashkent, when I was impressed by the thought of the enormous distances in the USSR. We set out by air from Moscow early in the morning and were told that we should arrive about mid-day the following day in Alma-Ata, a distance slightly less than that from Moscow to London. We were also to stop at three intermediate airfields, but owing to snowstorms and other troubles we landed at three different airfields. That did not worry the passengers who were bound for the intermediate places; they just sat down with their traditional patience and waited for a 'plane that might be going one day to their real destination. We sat tight and came down, to our great surprise in the middle of the night, at Balkhash, which when I was at school I thought of as a fairy-tale place. There is a large lake there and also an airport, consisting of a hut and a director, who was most kind to us. In addition he told us of a physical fact about the lake—that the water at one end was fresh and at the other end it was salt. The only evidence we had of salt water in the lake was when we were given fresh sturgeon to eat, it having come out of the west end of the lake. We arrived at Alma-Ata on a December morning; there was snow on the ground; it was frosty and cold but not as cold as in North Russia. From Alma-Ata we could see the white peaks of the Altai range separating the Kazakh S.S. Republic from China. When looking at the population there it seemed to us that most of the people in the towns were in fact Russians from the west; the Kazakh population seemed more numerous in the country and on the outskirts of the towns and they were engaged to a greater extent in agricultural pursuits, shepherding and so on. The notices in the towns are written in both Russian and Kazakh, but the Russian language seems to be the one used and generally understood. The shops were run largely by Russians. Next we got into a train for Tashkent.

When we arrived at our destination, we noticed that there seemed to be more of the Uzbek native population in the street than of Kazakhs, and we were driven from the station to our hotel by an Uzbek taxi driver. Tashkent itself, which has been very much built up with industry, as the lecturer has told us, differs little from any Russian town; indeed, the cities throughout Southern Russia are all on the Russian pattern and look like Moscow or Kiev. Otherwise we saw nothing very remarkable about the town. The climate of Tashkent was mostly warmer than that of Alma-Ata. We had no snow while in Tashkent. Apart from what I have said, Mr. President, I feel I am unable to express any opinion because that would not be "unclassified."

The PRESIDENT: I had intended to call on one or two others to speak, but the time has passed so quickly that in your name I now express a hearty vote of thanks to Colonel Wheeler for his most interesting and instructive lecture.

THE PATAGONIA ICE CAP

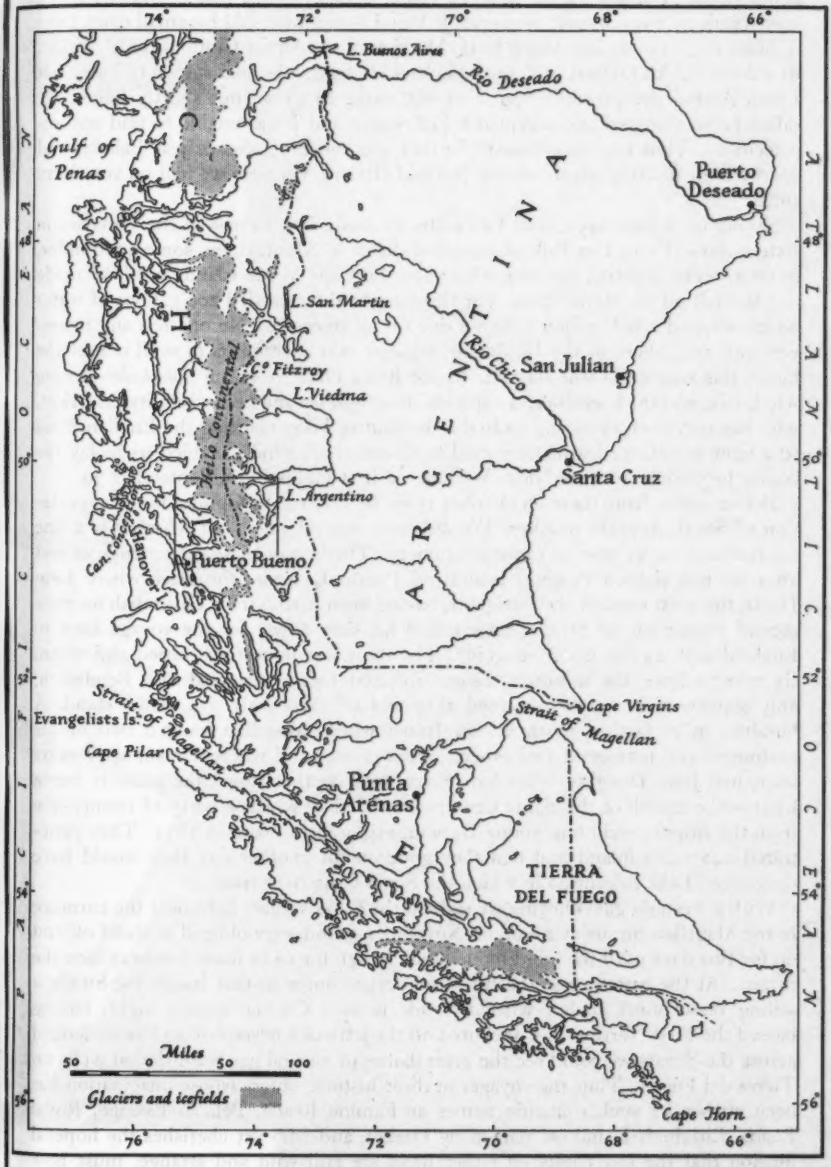
H. W. TILMAN

THERE ARE FEW places in the world where a man can sail to the foot of his climb. One such place is the southernmost coast of Chile where the glaciers come down into the sea. It is a region, therefore, which has a powerful attraction for a mountaineer who late in life catches sea fever and aspires to making a long ocean voyage with some mountains at the end of it. Such was the germ of an idea which led me to attempt a crossing of the Patagonia ice cap.

On the 1:1 million sheets of southern Chile compiled by the American Geographical Society are two white spaces, more or less blank, marked "inesplorado." These are the northern and southern portions of the ice cap, divided by the Rio Baker and extending from lat. 44° S. to lat. 51° 30′ S. The ice cap varies in height from 6000 to 10,000 feet, and in width from 15 to 50 miles. The highest mountain on it is San Valentino at the northern end (13,345 feet), which was climbed for the first time in 1953. It is the largest glaciated region of the temperate zone. Its northernmost glacier, the San Rafael, reaches the sea in lat. 46° 40′ S., farther from the pole than any Alaskan glacier by 10 degrees, and fully 20 degrees farther than the Jökelfjord, the most southern of the Norwegian glaciers which reach the sea. Darwin pointed out that this San Rafael glacier, 15 miles long and in one place 7 miles wide, pushes its ice into the sea at a point on the coast where, within less than 500 miles, palms grow.

The boundary between Chile and Argentina follows roughly the crest line of the Cordillera and all previous exploration has been from the Argentine side. Since 1914 many attempts to cross the ice cap have been made. It is reported that in 1954 an Argentine expedition led by a Major Huerta did succeed in crossing from Lake Argentino to the Pacific, but so far I have not been able to obtain any detailed information about it. On the Argentine side there are many glaciers which descend into the great lakes of Buenos Aires, Viedma, and Argentino, and there are estancias near the shores of these lakes. On the Chilean or Pacific side, where the weather is much less favourable, the glaciers descend to the waters of deep, narrow fjords, and there is nothing but ice, rock, and tangled rain forest. For nearly 1000 miles northwards from Punta Arenas the coast and the hundreds of islands are uninhabited. The Admiralty Pilot describes it as "about as inhospitable a land as is to be found in the globe. The land is mountainous, presenting an alternation of matted forest, bare rock, and deep bogs, and is intersected by many deep channels into peninsulas and islands as yet very imperfectly known. The scenery is magnificently stern; cloud and mist usually screen the higher peaks and snow fields."

Early in 1954 I acquired a boat suitable for this venture, an ex-Bristol Channel pilot cutter called *Mischief*, built in 1906. She measured 45 feet overall, 13 feet beam, and drew 7 feet 6 inches aft, with a displacement of about 50 tons. Of the attempt made that year the less said the better. We fitted out at Palma, Mallorca, where I had bought the boat, and upon reaching Gibraltar in late August the crew melted away, leaving me to consider how to get the boat home and to ponder the truth of the Chinese sage's remark that "discord is not sent down from heaven; it is brought about by women." In 1955 I had great difficulty in raising a crew. Finally it consisted of W. A. Procter, a retired Civil Servant who knew something


74°
72°
70°
68°
66°
L. Buenos Aires
Río Deseado
Gulf of Penas
Puerto Deseado
ARGENTINA
L. San Martin
Río Chico
San Julian
Cº Fitzroy
L. Viedma
Hielo Continental
Santa Cruz
L. Argentino
Can. Concepción
Glanover
Puerto Bueno
Strait of Magellan
Evangelists Is.
Cape Pilar
Cape Virgins
Strait of Magellan
Punta Arenas
TIERRA DEL FUEGO
Miles
50 0 50 100
Glaciers and icefields
Cape Horn
76°
74°
72°
70°
68°
66°
48°
50°
52°
54°
56°

about sailing; Captain M. R. Grove, a young Gunner officer who obtained a year's leave (without pay) in order to come; J. Van Tromp, who sold his small dairy farm in order to go to sea; and Major E. H. Marriott of the Alpine Club, the only climber to volunteer. An Oxford geologist, Michael Holland, who had agreed to join us at Punta Arenas the previous year, was still game to come, but shortly before we sailed he was offered and accepted a Fellowship and I was unable to find any replacement. Thus our eagerness to further the cause of science was balked, and apart from collecting plants for the Natural History Museum we had no very lofty aims.

Sailing on 6 July 1955 from Falmouth we made Las Palmas in the Canaries in sixteen days. From Las Palmas we sailed direct to Montevideo, some 4300 miles, in nine weeks, sighting no land other than the Cape Verde islands until we made our landfall off the River Plate. For this long haul we carried 200 gallons of water which allowed a half-gallon a man a day for all purposes. No one felt any inconvenience and when, in the Doldrums, copious rain enabled us to refill one of the tanks, this restriction was relaxed. In the River Plate we met a *sudestada*—strong wind, rain, and thick weather. In spite of the rough sea and poor visibility, Marriott, who has very keen eyesight, spotted a diminutive buoy marking the English Bank (the light vessel, we learnt later, had been removed) which enabled us to lay the course for Montevideo harbour. We entered it at midnight on September 30.

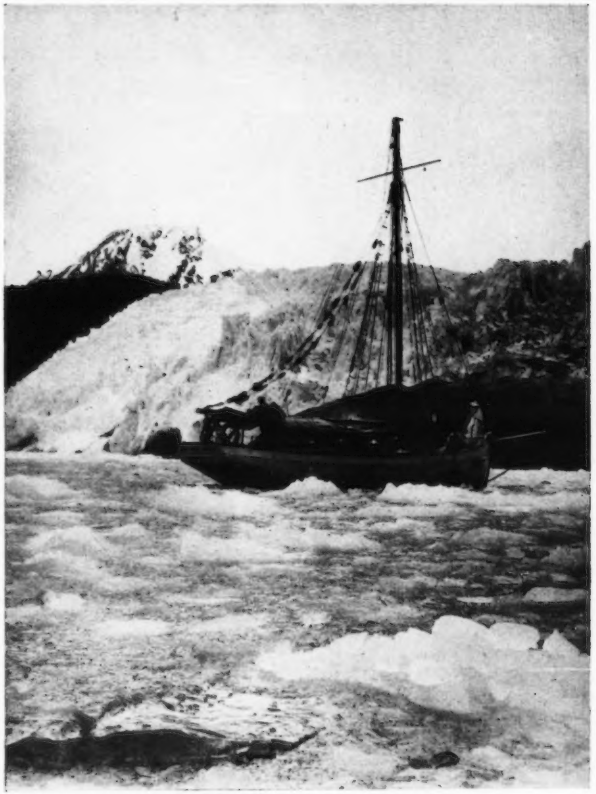
Before sailing from there on October 15 we sent down the topmast in the expectation of South Atlantic weather. We did meet several gales, but *Mischief* is a fine sea-boat and never gave us cause for anxiety. The first of these gales struck us just after we had sighted Penguin Island, off Puerto Deseado, the place where John Davis, the great seaman and navigator, having been parted from Cavendish on their second voyage to the Straits, revictualled his ship *Desire* for the voyage back to England with 14,000 dried penguins. The meat was imperfectly dried and when, six months later, the noisome, maggot-infested *Desire* struggled into Berehaven, only sixteen of her crew remained alive and of these only five could stand. A hundred miles farther south is San Julian where Magellan hanged two of his mutineers and marooned two others, one a priest; and where Drake, sixty years later, had John Doughty beheaded. Sixty miles farther down the coast is Santa Cruz at the mouth of the Santa Cruz river, the river which a party of twenty-five from the *Beagle*, including young Darwin, explored in boats in 1834. They penetrated 140 miles inland and had they gone on for another day they would have discovered Lake Argentino in which the Santa Cruz river rises.

With a westerly gale blowing we sighted the Cape Virgins light near the entrance to the Magellan Straits at 2 a.m. on November 5, and were obliged to stand off and on for two days until the wind moderated enough for us to make headway into the Straits. At the eastern end the tides run very strongly so that inside the Straits a sailing vessel must anchor when the tide is foul. On the second night, having passed the First Narrows, we anchored off the jetty of a *frigorifico*, and as we looked across the Straits we could see the great flames of natural gas from the oil wells on Tierra del Fuego. Thus the voyager in these historic waters whose imagination has been stirred by such romantic names as Famine Reach, Pelican Passage, Royal Roads, Elizabeth Island (so named by Drake), and who yet cherishes the hopeful illusion that the low coasts on either hand are still wild and strange, must now abandon such imaginings, for here they are for ever dispelled by the horrid reality of a *frigorifico* on the one hand and of oil derricks on the other.

Halfway through the Straits lies Punta Arenas, remarkable for having the

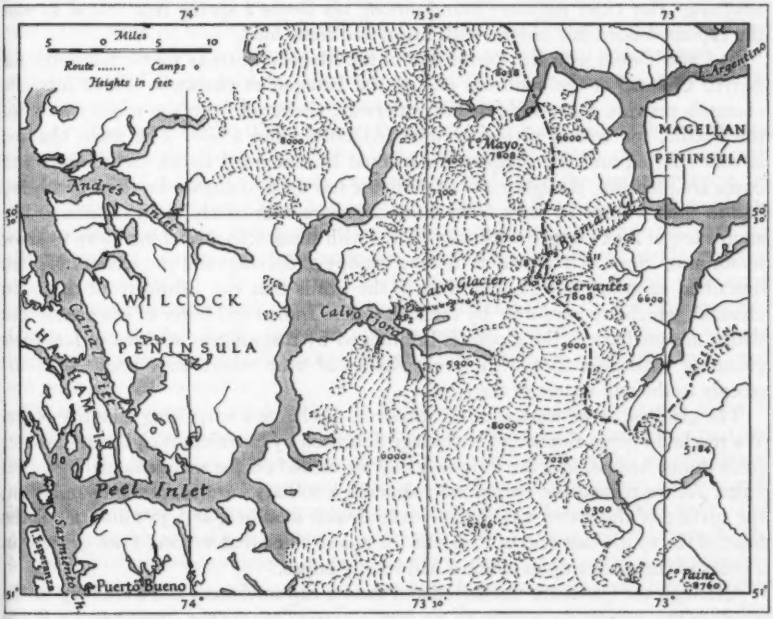
Cape Froward, southernmost point of the American continent

Glacier in Peel Inlet



Mischief *anchored off the Calvo glacier*

southernmost golf course in the world and a very strong climate. In summer it blows hard almost every day and in winter it is cold. The rapidly dwindling British colony—once such a power in the land that sterling currency was in general use—was very kind to us, and the Chilean navy went out of their way to help. Before sailing for Peel Inlet, the chosen fjord some 300 miles north where I hoped to effect a landing, I obtained the necessary third member for the shore party. Through the British Embassy at Montevideo, who passed it on to Santiago, I had made my want known in Chilean climbing circles, and now Jorge Quinteros, a young Chilean climber recommended by the Federacion de Andinismo de Chile, volunteered his services. He proved to be a capable mountaineer and a good companion. He knew very little English and I no Spanish, but there are times when it is



an advantage not to be able to converse—"the camel driver has his thoughts; and the camel, he has his."

On November 26 we sailed and next morning rounded Cape Froward, the southernmost point of the American continent. The cape marks a change in both scenery and climate. The low coast becomes high, rocky, fringed with dense rain forest, and snow-covered mountains loom on either hand. Even more striking was the worsening weather. Steady rain, bitter squalls of snow or hail, strong winds funnelled down the channels from dead ahead, were our daily portion. We carried two 40-gallon drums of petrol on deck in addition to full tanks of 70 gallons, our intention being to rely mainly upon the engine for navigating these narrow waterways, where the wind is generally contrary and where at night one has often to enter small bays or coves to anchor. This gave us a range of 600 miles, just enough

to get to Peel Inlet and back to Punta Arenas—for at that time we intended returning the same way—so I arranged with the Chilean navy to have another 40-gallon drum dumped at Puerto Bueno, an anchorage in the main channel close to the entrance to Peel Inlet.

Partly through the malignity of machinery and later owing to ill-timed curiosity on the part of the crew, these arrangements were not as useful as they should have been and we ended by throwing overboard petrol we could not use. Soon after rounding Cape Froward a valve spring broke and we had no replacement. Tacking every half-hour or so, we made good at best 20 miles a day and usually less than 10 miles. Peel Inlet seemed a long way off. But a week later, when anchored for the night in Columbine Cove, our luck turned. The *Maipo*, a Chilean naval store ship bound northwards, saw us, steamed in and anchored to learn if we wanted anything. Her chief engineer found among his stores a spring that would fit and the captain loaded our dinghy with bread and fresh food.

At Cape Tamar near the Pacific end of the Magellan Straits we turned north for Smyth Channel at the southern end of the Patagonian channels. These intricate channels provide a 400-mile inland waterway, sheltered from the mighty swell of the Pacific, for vessels plying between Argentina and Chile. The main channel is well charted and the dangers are marked by untended lights. Small bays and coves are plentiful, though many of them are too deep to anchor in. Frequently we had to anchor some 30 yards from the rocky shore with barely room to swing. The shores are of rock clothed with rain forest, with bleak fells stretching away to snow mountains. Seen as it usually is under a canopy of driving rain, the scenery is often described as grand but gloomy. But in the fjords that run inland from the main channel, which are used only by the rare Canoe Indian or hunter of sea otters, and which are uncharted, the gloom is brightened by magnificent streams of ice, their gleaming whiteness shot with lovely shades of blue where they break and curl steeply to the still waters of the fjord.

The glaciers, as we were about to discover, discharge a surprising quantity of ice. We reached Puerto Bueno (an anchorage first used by Sarmiento) eighteen days out from Punta Arenas, and the following day we turned off the main channel into Peel Inlet. As we turned the corner we remarked a solitary ice floe. Twenty miles on, the surface of the water was almost covered with loose ice, and 30 miles on, at the head of the south-east arm of Peel, the ice was so thick that we could not get within 2 miles of the glacier upon which I had set my hopes.

Although the fjords are uncharted and the ice cap unvisited, there is a map of the whole of this region made from an air survey carried out by the American Air Force in the years after the war. These maps are on $\frac{1}{4}$-inch scale. They show individual glaciers, heights of mountains, and the coastline of the fjords, but, of course, no soundings.

As the glacier we had picked on from the map was unapproachable we entered the northern arm of Peel Inlet where there are some ten glaciers which reach the water. Such glaciers afford the only way inland, for the rain forest which extends to 1500 or 2000 feet above sea level is an effective barrier. In Calvo Fjord, an easterly branch of Peel, we found a glacier which looked approachable. Going dead slow we forced poor *Mischief* through a mile of thick ice floes to an anchorage within 50 yards of the glacier snout. From this masses of ice fell frequently with a terrible roar, and as our cable rattled out, steamer ducks scuttled away in fright, a penguin bobbed up, and from a nearby cave a sea-lion bellowed in astonishment. It was a most uneasy anchorage; huge floes, some as big as a cottage with its garden thrown in, drifted

around, and on our first night there one of these capsized with a rending crash which brought all hands on deck with a run to see the water boiling and surging and lumps of ice shooting to the surface.

It was no place for the ship to linger and no time was lost in making a reconnaissance. For nearly a mile we made good progress on a small moraine between glacier and forested hillside until stopped at a place where the glacier impinged against a rock wall. The flank of the Calvo Glacier, as we called it, was terribly broken but, after forcing a way through half-a-mile of shattered ice, we emerged on better going in mid-glacier. But progress up the glacier was barred by a belt of seracs and chasms right across its 1-mile width. Our first reconnaissance was thus indecisive, but we trusted to luck to find a way and began landing stores. On December 18 we slept at the foot of the glacier and the ship sailed for a safer anchorage. The crew's instructions were to remain at Puerto Bueno until 1 January 1956 when they were to return to Calvo Fjord, find a safe anchorage, and cruise off the glacier every Sunday to look for signals. The shore party had seven weeks' food and I expected to be back by the end of January. If we had not returned by February 12 the ship was to make its way to Punta Arenas.

For its first 2 miles the Calvo Glacier is extremely broken. Nor is there any way of avoiding this part by taking to the rocks, for they are steep and clothed with tangled, matted forest. On the way back we climbed down through this forest, an experience which confirmed our opinion that to carry loads up through it would be impossible. The whole of the first fortnight was spent in finding a route and carrying all our stores to Camp 4 at about 2600 feet, clear of the seracs and within reach of névé-covered glacier. The route went right across the glacier to Camp 3 on some rocks on the true right bank, and then back above the belt of chasms and seracs to Camp 4 on the left bank, the side upon which we had first landed. It was an intricate route and to move each camp forward involved three carries, for we started out with 450 lbs. of stores.

Once we were on the névé we had no difficulty except for the crevasses, many of which were not yet open. We had to exercise the utmost care, and with a party of only two the traversing of the glacier would not have been justified. At one time I thought the party would be reduced to two, for Marriott was having trouble with his feet. However, he struggled on gamely and did his full share of the work. The glacier ascends gradually for about 12 miles to a wide, shallow col which marks the beginning of the ice cap proper, a wide, gently undulating expanse of crevasse-free névé stretching away to the north and south with peaks rising from it for another 2000 or 3000 feet. Camps 5, 6, and 7 were on the glacier, the last about 500 feet below the col.

Camp 8 was on the ice cap at about 7400 feet. We reached it on January 13 on the third of a run of brilliantly fine days. We stood on the Argentina–Chile frontier and the Pacific–Atlantic watershed. Far below lay the wrinkled Bismark glacier pushing its distant snout out into the water of Lake Argentino, which we could easily see, and in all directions unnamed, unclimbed peaks stood up from the wide, glistening snow field. We left our camp on the Bismark Saddle, as we called it, and descended about 2000 feet to have a look at the glacier which appeared to be even more broken than the Calvo. It was no good, but casting back we found a narrow gap in the Cervantes ridge, which bounds the Argentine side of the ice cap, and this led us down to the névé of an eastern arm of the Bismark Glacier. Having circled this arm to the far side we pitched Camp 10 on some rock, thus reaching dry land, as it were, in Argentina.

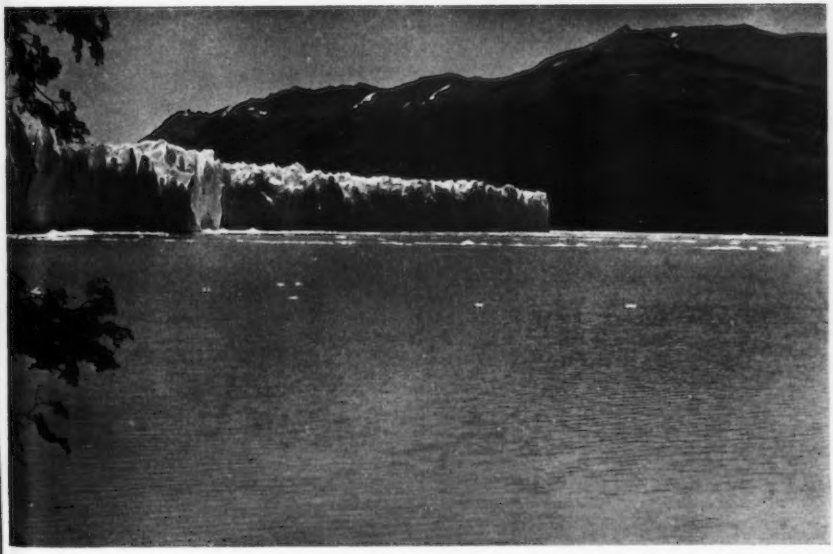
From this camp there was about 7 miles of hard going on ice, rock and finally through forest to the thickly wooded shore of the lake. Hard by was the great tongue of blue, pinnacled ice over 100 feet high which projects into the lake for nearly a mile. From this, ice fell frequently with a thunderous roar, setting up small tidal waves in its fall and covering the lake with miniature bergs. The near presence of one of these obliged me to cut my ceremonial bathe to mere seconds. The proximity of ice and forest is strange. One walks through open forest of Antarctic beech upon a carpet of yellow violets, while through the trees only a few yards away looms this monstrous wall of ice. The glacier appeared to be stationary or in very slow retreat. Moraine is scanty and sometimes nothing but a line of fallen trees marks the limit of the ice.

On the way back to camp, Jorge and I were benighted, but the eastern side is dry and we lay happily under the trees on a carpet of dry leaves before a memorable blaze. Next day as we began the journey back the weather broke. For thirty-six hours we lay in a camp below the Calvo pass while a blizzard raged. By then our food was finished, so in the afternoon we moved up to a camp on the ice cap where it was still blowing hard and the air was thick with driven snow. Our immediate problem was to find the dump containing two days' food and all my exposed film. On the way over, through sheer weariness, I had very foolishly put this dump about 500 yards from a prominent cleft in the ice instead of right by it. We found the cleft but in our first attempt to find the dump we were all at sea. The loss of my film was serious but quite overshadowed by the loss of the food. The suggestion was mooted of a retreat to Argentina—all the way back to the lake and 50 miles round it to the nearest estancia on a 2-lb. tin of biscuit which we had stupidly left at the lake camp. But if only for the sake of the ship's party, who would have had a hard time getting her back to Punta Arenas, we must reach the ship.

We moved on in sombre mood, haunted by the fear that the dump at Camp 7 would likewise be drifted over. Before we had gone far, a glimpse of the sun through the flying scud and a slackening of the drift encouraged us to make another search. Marriott and I separated leaving Jorge by the loads—for it would not do to lose them—and presently Marriott spotted a tiny dark shape. A corner of the topmost tin on the 2-foot-high dump was just visible above the snow. The dump at Camp 7 was never found, but now we had a day's food in hand and there was another dump at Camp 4. From there we avoided the broken part of the glacier by climbing over a small mountain until we reached a point some 2000 feet above the base camp. To descend through the matted tangle of bush and fallen trees proved possible though not pleasurable. We fell part of the way and after a fierce struggle emerged on the moraine tattered and scratched, but only a few hundred yards from the sea.

Next day, January 29, we were picked up by the dinghy. It had to be shoved and pulled through 4 miles of ice floes in order to reach *Mischief* whose engine was once more out of use. Curiosity had persuaded them to explore the northern arm of the inlet where the ship struck hard and fast on a rock reef. They had had to sheer her up on legs to prevent her falling over and to ferry ashore 3 tons of ballast before she floated off. Meantime she had been battered by ice floes which had stripped and bent the propeller. It was a happy reunion, a little marred by this incident, for I did not relish the journey back to Punta Arenas under sail alone. We decided to cut the navigation of the channels as short as possible by going out into the Pacific and then north to Valparaiso for the necessary repairs. After I had come within yards of putting her aground for good when she missed stays in a gale, we reached the Pacific by Canal Concepcion in lat. 51° S. We had a rough welcome. With strong

South-eastern end of Peel Inlet, showing the glacier the expedition first hoped to land on



The 100-foot ice wall of the Bismark glacier in Lake Argentino

Camp 5 (about 4000 feet); looking north across the Calvo glacier

head winds, a split mainsail, and three of the crew for various reasons out of action, I pondered the doubtful step of running before the wind and rounding Cape Horn. However, we hung on for a few days, making no northing at all, until at length we got a favourable slant of wind. As we began to get north the weather improved and we had a fast run to Valparaiso which we reached on February 24.

Thereafter all was plain sailing. We spent three weeks in Valparaiso, including five days in dry dock, and then sailed for the Panama Canal, calling only at Callao. From Cristobal, at the Atlantic end of the Canal, we went north through the Yucatan channel and the Florida Straits (where we got a lift of 70 miles a day from the Gulf Stream) and thence to Bermuda. The Atlantic crossing of 3300 miles took thirty-two days, and we sailed up Channel past Falmouth in a dense fog exactly a year and a day after leaving it.

DISCUSSION

Evening Meeting, 18 February 1957

Before the paper the PRESIDENT (General Sir JAMES MARSHALL-CORNWALL) said: This evening we shall hear a saga of adventurous exploration, of exploring the hard way after the fashion of the early navigators. It is a story of a small party setting out in a small sailing craft, rather like our Anglo-Saxon and Viking ancestors, to seek a distant objective beyond a wild rock-bound coast beset by stormy seas. Major Tilman, Bill Tilman to his friends, is a distinguished traveller and mountaineer. He was the pioneer of this really extraordinary expedition. He is not unknown to this Society, for in 1952 he was awarded our Founder's Medal. In 1936 he was the first climber to make the ascent of that great Himalayan peak, Nanda Devi, over 25,000 feet. He was the leader of our 1938 Everest Expedition. His mountain travels have ranged from East Africa to Sinkiang and Nepal, and those mountain travels were not even interrupted by the last war, for he was parachuted into the mountains of Albania and northern Italy to fight alongside the partisans. This evening Major Tilman will describe to us his latest effort at getting into and out of "Mischief."

Major Tilman then read his paper

The PRESIDENT: It would be presumptuous for me to comment on that wonderful story. I would like, however, to say that before Major Tilman became a famous explorer he was an officer of the Royal Artillery and two years ago, when he was proposing to go on this expedition to Patagonia, he wrote to me as another Gunner suggesting I might pull a string at the War Office to get a year's leave of absence, without pay of course, for a young officer, Captain Michael Grove, of the Royal Artillery. I wrote at once to the Adjutant-General to the Forces who, strange to say, was another Gunner and, needless to say, permission was granted. I do not wish to infer that the Royal Artillery has any particular pull at the War Office; I am sure Michael Grove would have been granted leave of absence as readily if he had been an officer in the Loamshire Light Infantry. At any rate, he got his leave and the result was that, out of *Mischief's* crew of five, three were members of the Royal Artillery.

The officer who was Adjutant-General to the Forces at that time, two years ago, was General Sir Cameron Nicholson; he handed over his appointment as Adjutant-General about six months ago to, believe it or not, another officer of the Royal Artillery. It seems we are having rather a benefit performance by the Royal Artillery tonight, and we fortunately have as our guest of honour General Sir Cameron Nicholson, who is no longer Adjutant-General to the Forces, but six months ago took over the most dignified and honourable post of Master Gunner, St. James's Park, from that greatest of living Gunners, Field-Marshal Lord Alanbrooke. I now ask Sir Cameron Nicholson to say a few words, especially to those of us who are *not* Gunners.

General Sir CAMERON NICHOLSON: Thank you, General, for what you have said, and thank you also for your hospitality tonight, which has given us the privilege of listening to this quite remarkable story of enterprise and adventure. Many years ago at the Royal Military Academy, Woolwich, the old "Shop," Bill Tilman and I, being in the same Cadet term, shared many things, often punishments, together, and my respect for him on those meritorious occasions has now grown into a profound admiration in view of this wonderful story we have heard tonight. Your President has been kind enough to refer to the help which the Army has been able to provide on these expeditions. The boot is really on the other foot: it is the Army which has to thank the Society for the opportunities for adventure which you offer to us. We would not want to miss a single chance for an officer to gain such invaluable experience. In recent years, thanks to the Royal Geographical Society, to the British Schools Exploring Society, to that great man who has gone now, Surgeon-Commander Murray Levick, to the Outward Bound Trust, the number of opportunities offered to the Forces is increasing, and in my own Regiment, the Gunners, with our geographically worldwide type of perambulations, our aim is to encourage the young officer to take part in all forms of adventurous sport wherever he may be and to meet such widely different conditions as are found in Hongkong, Malaya, West Africa, the Middle East, Germany and those other countries where our units are. We run our regimental Alpine and other clubs. Thus we are working on more or less parallel lines to the Society who, I understand, give special facilities to the universities. Far-flung as we are in the Regiment, with so many places to look after, we need as many leaders with experience, such as you have given to this expedition, as can be trained, and we are more than grateful, Mr. President, for the inspiring invitations which have been extended to us by your Society.

THE CANNING BASIN OF WESTERN AUSTRALIA

MICHAEL TERRY

WITH ITS CENTRE at approximately long. 124° E., lat. 20° S. (or 1000 miles north of Perth, the State capital) there exists in Western Australia a huge, virtually uninhabited region. Its features consist of scattered, table-top hills and almost universal sandhills and, since the initial penetration by Colonel Warburton in 1873, it has received probably less attention than any other portion of inland Australia. Its potential as an oil-bearing area has, however, excited some interest since 1922 when the Locke Oil Syndicate made a cursory examination But it has taken the discovery of flow oil at Rough Range near the North West Cape, during November 1953, to rouse interest in the thorough determination of the geology of this region, whose centre (for practical purposes) has been taken as Joanna Spring. The region has recently been renamed "The Canning Basin" after the late Surveyor-General of Western Australia, A. W. Canning, and the name is particularly appropriate for it is already commemorated in the Canning Stock Route, laid down by Canning during 1908–9–10 for more than 700 miles from Wiluna to Halls Creek. The object of this venture was to stimulate the movement of cattle from The Kimberleys to the nearest railhead at Wiluna, and thence to the metropolitan markets in Perth and on the Goldfields. Every 15 to 20 miles Canning sank wells and equipped them with troughing and windlasses, either by opening up existing wells sunk by aboriginals or by putting down bores. The stock route was gazetted as being 5 miles wide.

During 1911 drovers began to move cattle down the route from The Kimberleys, the first to do so being Thompson and Shoesmith; they, alas, were attacked by blacks and murdered at No. 37 Well, known to the tribesmen as Libral. T. Cole, following a few days behind them, found their bodies, and then went on south. He reached Wiluna six months after starting, with the beasts in excellent condition, and suffered only one or two losses. But since then the equipment of the stock route has fallen into decay, being used hardly at all, and then principally during the recent war when a few drovers moved cattle south as the Japanese were bombing the Kimberley cattle boats en route to Perth. Thus Canning's original intention, to provide an alternative way to move cattle south, instead of by sea, was again proved practical.

Today a subsidiary of California-Texas and Australian Motorists Petrol Company, the West Australian Petroleum Co. Ltd. (briefly known as "Wapet"), holds an oil-prospecting permit (No. 30H) over an area of 151,000 square miles within the Canning Basin, and for a short way beyond the coastline. From Mount Blaze, on the coast, the boundary of this permit runs to its south-east corner at 23° 47′ S. and 125° 23′ E.; thence north-east to 19° 45′ S. and 128° 20′ E. (where it turns towards the coast), and ends at 16° 7′ S. and 122° 47′ E. in the Buccaneer Archipelago.

The huge area of the Canning Basin, about 210,000 square miles, may be described with comparative simplicity, being a region of few mountains and of universal sandhills. Its elevation varies from nil at the Eighty Mile Beach between Broome and Port Hedland, to 1080 feet at the base of the Southesk Tablelands

(Terry, 1925), and to 1700 feet at the Stansmore Range (B.M.R., 1955), and 1240 feet at the border of the Northern Territory (Terry, 1933). The first height was determined by hypsometrical apparatus lent by the R.G.S.: the last by aneroid reading corrected by the Commonwealth Meteorological Bureau. Incidentally, such other readings by Terry in 1925 as were checked by the Bureau of Mineral Resources in 1955 were found to be only ±20 feet, which may be regarded as remarkably close for uncontrolled barometrical work done thirty years apart.

The predominant characteristics of this region are the almost unvarying red colour of the sand, and its nearly parallel sandhills which trend slightly to the north of west. Their crests normally rise to 60 feet above the local contour but sometimes to 120 feet. When descending the latter I have had camels slide down with their back legs tucked under them, and ascend on their knees. More than once a camel has swerved sideways in descent and toppled over with disastrous consequences to its load and saddle.

These dunes are of the fixed *seif* type. They form ridges mainly a quarter of a mile apart and can extend unbroken for 50 miles, varying only slightly in direction.

Junction between dunes is quite common and they are often braided, giving them three or four crests. Wind erosion also has created hollows along the crests so that crossing them can be very complex. The southern flank is usually, but not always, the steeper. The only sustained change in colour and direction in these dunes is adjacent to the coast where the sand is white and the trend parallel to the shore, or roughly north–south.

The sand, which masks most of the outcrops in the desert, originates either directly from the underlying ferruginized Mesozoic and Permian sandstones or possibly from a poorly formed laterite over sandstone. These red sands are essentially quartz grains coated with a film of iron oxide, but chemical tests have so far failed to establish from which source they were derived. The sand is medium-grained, increasing to coarse-grained where it overlies (and probably originates from) granite. The depth of sand in the inter-dune valleys is unknown, but travertine protrudes through it in places. Such movement as occurs is to be found along the crests of the dunes and is from east to west, but the sand has probably not been transported far from its source because the grains are not well sorted. Samples of them are being investigated by J. Ward (Bureau of Mineral Resources) whose results so far show that the grains vary in size from 0·43 to 0·25 millimetres. The most northerly, probably derived from Cretaceous fine-grained sandstone, are the finest. In comparison, Libyan desert sands have a diameter from 0·8 to 0·08 millimetres, whereas samples from Simpson's desert, north of Lake Eyre (South Australia), measure from 0·24 to 0·06 millimetres.

Except where the aboriginals have lighted a fire to drive rodents from cover, the terrain is covered by universal tufts and mounds of the tough, wiry, green spinifex (sp. Triodia), a large variety of small desert shrubs (chiefly of the acacia and eucalyptus families) and curious clumps of white desert gum trees along the tops of the sandhills. The presence of these trees is a curiosity, since they have elected to grow quite naturally upon apparently so unstable a surface. By their growth they indicate that such sand movement as occurs today is superficial where they are growing, and emphasise the fixed *seif* character of their habitat. Although they are seen usually in a line along the crest I recall on several occasions seeing them extending as a line across a sandhill, over the intervening valley, up over the next sandhill and then beyond it for several miles. It is as if an erosion control had been established by man, but such a thing is quite out of the question. After spinifex has been burnt off, either by lightning strikes or by blacks, a lush growth of grasses and native flowers springs up after rain, but as drought sets in once more they wither and the spinifex takes over again. This may extend till the mounds are 4 feet across, when the centre withers and a "doughnut" effect results. The annual rainfall is unreliable and irregular: from 5 to 10 inches a year.

As a rule where water drains from a range or some high ground the course is marked by a large variety of shrubs and small trees. In the immediate vicinity of sub-surface water there is always an improvement in the vegetation however bad the season. In fact, the shrubs and their types indicate where to sink for water if it is not actually on the surface. Native wells are almost invariably surrounded by stunted ti-tree and travertine. Canning used this knowledge to select his well sites, establishing the presence of ample subterranean water from a few feet below the surface to a maximum depth of 100 feet. It was seldom necessary to sink more than 30 feet and this often by deepening native wells sunk laboriously by aboriginals with wooden implements to perhaps 15 feet. The women do most of this work, often completing it held by the feet head first down the funnel-shaped opening, and

passing back the dirt scooped into a wooden *coolamon* (shaped like a boat about 18 inches long) to helpers, till it reaches the surface. When such a well is not being used the natives will stuff branches, or whatever is available, down the hole to afford protection from the sun and thus retard evaporation. This, speaking from sad experience, makes the supply incredibly unpleasant for the white man.

Besides native wells there are "gnamma" holes which can be found at the base or on top of "breakaways;" in fact, beside or on top of any rocky eminence where the surface is sufficiently free of sand and too impermeable to collect rainwater. Somehow holes are worn in the conglomerate with an opening from a few inches in diameter to as much as 5 feet across, and to a depth as great as 14 feet. They withstand drought particularly well and the more severe the conditions the more easily they can be traced by the flights of small birds, notably Java sparrows, painted finches and budgerigars, which water there at sun-up, noon and sundown.

There is also the true rock hole usually associated with the face of a range, where water pouring from above during a storm wears away a catchment that, in the case of Godfrey's Tank in the Southesk Tablelands, its discoverer David Carnegie estimated at that time to contain 40,000 gallons; but when we saw it in 1925 it was dry. Incidentally Carnegie carved C96 in the rock beside this place but after a time that piece of rock fretted away and so Canning cut the sign afresh, leaving beside it a broad arrow surmounting C23. What one might call the normal rockhole is vastly inferior to the spectacular Godfrey's Tank. It is a minor thing, holding from 50 to 500 gallons and perhaps the least reliable source of water, its life being subject to whatever the sun and the wind decide after it has been replenished.

There are a few springs in the Canning Basin, yet most of them are not true to name, being, as a rule, simply very good native wells which yield a better supply when opened up by the white traveller. There are also sand soaks, perhaps up a rift in a low sandstone range, where some work with a shovel will produce an invaluable supply for man and beast. Nevertheless, generally speaking the region is a most dangerous place for the wanderer and only the most experienced can survive whether using camels or modern motor transport. Even L. A. Wells lost two men near Joanna Spring in 1896 and a party under F. Reeves (Vacuum Oil Co.) nearly perished in 1949 when their jeep broke down inland from Anna Plains station on the Eighty Mile Beach.

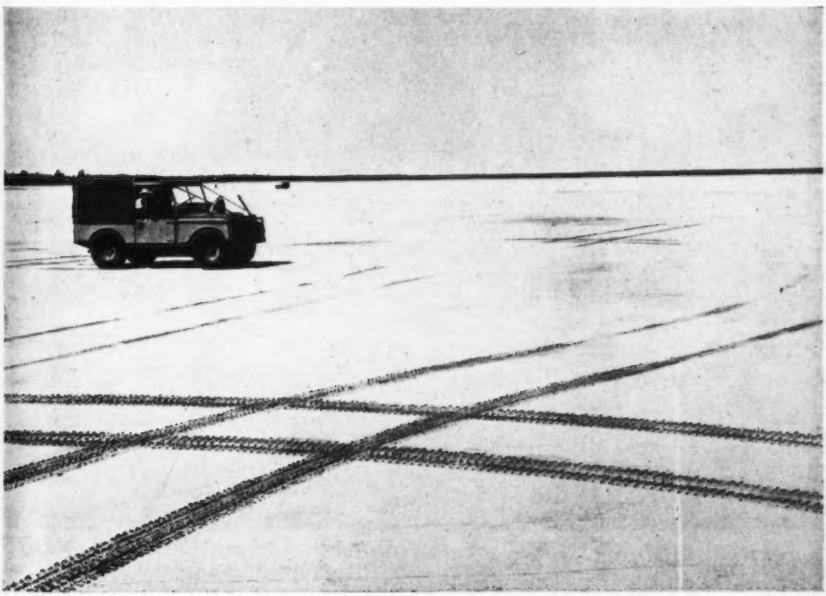
Such "lakes" as are marked within the Canning Basin are indeed merely salt pans which rarely hold water at all and then only briefly and to a depth of inches. For all practical purposes they are dry, gleaming white, and most trying on the eyes in the glare of the sun. Over them a riding camel, if it can be persuaded, can make its way; but its heavily laden brother, the pack camel, will almost surely break through the white crust and sink to its belly in green slime, whence it can be extricated only by unloading everything, carrying everything to the shore, then digging a great hole and working the wretched animal sideways onto bushes and sticks so that it may struggle to its feet. Such was our experience when trying to avoid a long detour at Lake Mackay in 1933.

The latest light motor vehicles with sufficiently large tyres and at full speed have more chance of crossing these lakes if they can overcome the especial danger where a low hill or outcrop borders the edge. The lakes in the south-west of the Canning Basin are treacherous all over, though some you may use near the shore where it is clear. In the northern section of this desert the pitfalls are less dangerous.

The examination of this area, long before it was renamed after Canning, dates back to A. C. Gregory (1861) who surveyed the southern margin near the Oakover

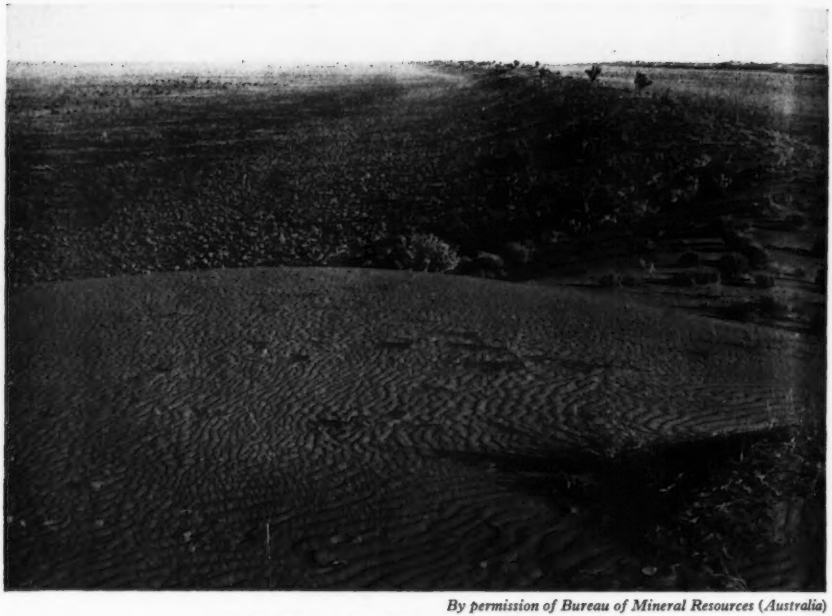
By permission of Bureau of Mineral Resources (Australia)

Parallel sand dunes with light-coloured fire-burn patterns, from air photographs taken east of Lake Wooloomber (scale $\frac{3}{4}$ mile to 1 inch)



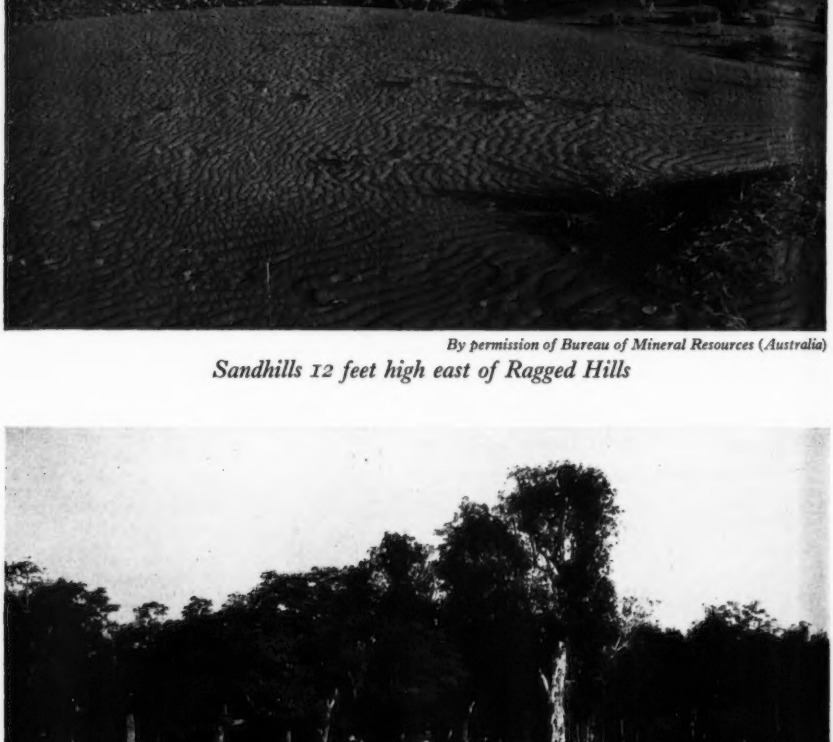
By permission of Bureau of Mineral Resources (Australia)

Lake Dora, looking south, showing salt crust



By permission of Bureau of Mineral Resources (Australia)

Sandhills 12 feet high east of Ragged Hills



Photograph: M. Terry (1928)

Eil Eil Springs: one of the few large permanent springs in the Canning Basin, amid typical sandhill and spinifex country

and Nullagine rivers. Settlement about these rivers was being established by cattlemen when Colonel Warburton (1873) completed the first great desert journey with camels and crossed east–west via Joanna Spring to the Oakover river. Having named it the "Great Sandy Desert," he did the initial reconnaissance but places marked along his route were considerably in error as he over-estimated his camel speed. Instances are Joanna Spring, 18 miles too far west; Lake Lucas, 30 miles too far west. L. A. Wells crossed south–north, via Separation Well and Joanna Spring, losing C. F. Wells and G. L. Jones near the latter. Incidentally, one of his camel-drivers, Bejah Dervish, was originally from Baluchistan and was decorated for service under Lord Roberts; he is still alive at Marree, South Australia.[1] W. F. Rudall (1897) searched widely near Lake Dora for Wells' missing men whose bodies were found eventually by Wells himself in April 1897.

The Hon. David Carnegie (1896) made perhaps the most memorable crossing in that it was a double one; he went north, via Godfrey's Tank, and south, further east, by the Stansmore Range. Two years later R. N. Smith searched the Nullagine-Oakover area for artesian water, but the first geologist was Gibb Maitland (1904) whose work has become the basis for all subsequent workers in the Pilbara area. After Canning's survey (1906–7) which led to the laying down of his stock route, W. H. B. Talbot (1910) provided the first accurate geological account of the desert area. L. J. Jones (1922) prospecting on behalf of the Locke Oil Syndicate found Permian fossils at Well 27 on the Stock Route. E. Kidson (1914) recorded magnetic observations at all well sites and waterholes. F. G. Clapp (1924) reached the McLarty Hills from the north and collected fossils near there for an oil company. M. Terry (1925) reached Godfrey's Tank from the north with half-track light trucks; in 1928, M. Terry flew 100 miles inland from Wallal station on the Eighty Mile Beach, then penetrated with six-wheelers a similar distance to Mount Morris. Later, in 1933, he reached the eastern limit of the Canning Basin from Alice Springs. D. Mackay flew over the area from Central Australia during 1930–33–35–37. C. Bunny (1940) flew over it again from the West Australian side for an American oil company. F. Reeves (1949), for the Vacuum Oil Co., extensively surveyed the south-west portion of the Canning Basin. "Wapet" geologists (1954) surveyed from Anna Plains to McLarty Hills.

Under a State-Commonwealth arrangement, the Bureau of Mineral Resources, Canberra, has been doing all sedimentary mapping in the northern part of Western Australia for many years. The State Survey is fully occupied with its own southern local geology and mining problems. The B.M.R. started operations under D. J. Guppy in the Fitzroy Basin (which forms the northern part of the Canning Basin) during 1948 and continued field work during the next four years. Then in 1953 their palaeontologists had to collect specimens all over again, after a fire in the University College, Canberra, had destroyed the original collection. The following year the B.M.R. survey launched out into the Canning Basin proper with a motorized party under D. M. Traves and studied the southern portion as far as the Canning Stock Route. In 1955 this work continued under J. N. Casey in the north-east portion where, in conjunction with a "Wapet" geological survey party, the work was extended eastwards to the border of the Northern Territory. During 1956 a third expedition, under B. Stinear, amplified the work further east, including examination of Hidden Basin (Terry, 1933). The ultimate aim is to reconcile the geology of the Canning Basin with the Lower Palaeozoic areas of south of the MacDonnell Ranges in Central Australia.

[1] The death of Bejah Dervish was reported in *The Times* of 7 May 1957.

During the 1954 and 1955 B.M.R. expeditions, surveyors from the Department of Lands and Survey (Western Australia) accompanied the parties to take the astrofixes which were essential if full advantage was to be derived from the mosaic of aerial photographs taken by the Royal Australian Air Force during May and June 1953. Where possible, such land controls were obtained near the corners of each mosaic as well as on the north–south tie-runs. As a result of a great deal of post-war flying by the R.A.A.F. there is now complete air photographic coverage from the Eighty Mile Beach to the Northern Territory border, also as far north as Darwin and as far south as Lake Disappointment. The aerial survey of the Canning Basin was flown by No. 87 (P.R.) Squadron using Mosquito aircraft operating from Port Hedland; the squadron has since been disbanded. Under Squadron-Leader C. H. D. Brown, flying took place at 25,000 feet. Fairchild K17 cameras were used with a 6-inch lens; the scale was 1 : 50,000. The area was flown in 4-mile sheets and about fifteen east–west runs covered each sheet, and each photograph and each run overlapped by 25 per cent. Three north–south runs were first flown—one at the east end, one at the west end, and one centrally; the east–west runs were flown from print to print as plotted by the Army Survey Company on the tie-runs. No system of ground control was used but reliance was placed on the north–south runs which were navigated on dead reckoning. Thus the Canning Basin is now covered by thirty 4-mile sheets, *i.e.* on the military grid of 4 miles to the inch. Incidentally, only ten of these sheets show vehicle tracks.

This paper has been prepared out of admiration for the field work performed by the B.M.R. in what remains even today the least hospitable part of Australia; and also to put into perspective the efforts and contributions of all notable people since A. C. Gregory who have provided us today with the rapidly widening knowledge of an area which may become significant. In 1938 I had plans ready to try to cross from Hidden Basin to Marble Bar but, perhaps fortunately, my health gave trouble, and the project with camels had to be abandoned. Then there existed some 90,000 square miles of almost unknown country, between the two aforementioned points, where mapping was most unreliable, water an unknown factor, and geological knowledge of the scantiest. Today mapping is complete and accurate, geological survey, especially along the fringe of the Canning Basin, is greatly advanced and modern motor vehicles, modified for specific purposes, have proved superior to the camel. It must be conceded, however, that unusually good rains had fallen just before motor transport began to be used. This eased considerably the problem of traversing the sand dunes, though it did also add to the risks in crossing the salt lakes.

Three modified Land Rovers and a Commer 3-ton 4×4 truck comprised the 1954 B.M.R. transport. The former were protected by $\frac{1}{8}$-inch steel plating underneath the engine, transmission, controls and tank. A steel bumper bar with steel mesh attached and a tubular scrub deflector virtually allowed the vehicle to disregard the low scrub. Needless to say, the weak link was the tyres. The sand-track tyres used (9·00×13) enabled the machines to cross all dunes somewhere and some dunes everywhere, but these large tyres did suffer a great deal through puncturing by wood spikes in the scrub. The "Wapet" expedition, although it did not cross many dunes and did not use this size of sand-tyre, averaged forty punctures a week. Sand-tyre pressures were 18–20 lbs. per square inch for soft sand and 22–24 lbs. per square inch for general travel.

Petrol consumption in the desert dropped to 6 miles per gallon, but rose to 10 miles per gallon when returning over the same tracks. Besides extra water and fuel tanks, general equipment included a Treager type 51 M.A. transceiver fitted

behind the passenger seat of one Land Rover. A model 43 transceiver was left at Warrawagine station so that daily contact could be made by the party with their base and with the Flying Doctor Service at Port Hedland, at 1700 hours with the medium wave (4030 kilocycles). The cooling system was standard, and was found sufficient except when travelling with the wind, when the engine heated up to nearly boiling point. Fire extinguishers were important because the spinifex often packs round the exhaust pipe and can catch alight.

The average daily stage was 30–35 miles, although this varied a great deal according to the country. Where dunes were high, defined, persistent, and about half a mile apart, inter-dune travel improved to 45 miles a day. On recent fire-burns, the hummocked sand around the spinifex being dispersed, travel was quite good. The worst places were near salt lakes where small undefined dunes, with sand in hummocks and often mixed with recent travertine, reduced the daily distances to as low as 20 miles. Under such conditions the quickness of a motorized party differs but little from that of a camel party which, water permitting, should average 100 miles a week.

As a result of all contributions to knowledge—from Gibb Maitland in 1904 to the Bureau of Mineral Resources in 1955—the geology of the borders, and to some extent of the central parts, of the Canning Basin is now a long way towards being determined, and will be further so after reports on fieldwork during 1956. A summary of the latest material made available by the B.M.R. shows that Gentilli and Fairbridge (1951) first referred to the Palaeozoic-Mesozoic sedimentary basin between the Pilbara and the Kimberley blocks (including the extension on to the present submarine continental shelf) as "The Canning Basin." It is defined for geological purposes as lying between the areas of pre-Cambrian rocks in the foregoing districts, though it does extend north-westwards under the ocean and contains younger sediments than Palaeozoic.

Unconformities show that the oldest tectonic units in the area are the Halls Creek Metamorphics of the northern margin of the Basin and the metamorphic and granitic rocks of the Pilbara region at the southern margin. Near both margins these tectonic units crop out as inliers far into the Palaeozoic Basin.

Resting unconformably on the rocks of these oldest tectonic units, generally at some distance outside the margin of the Basin, are sediments and volcanics generally only moderately deformed. The northern Kimberley Block probably derived its sediment from the south in an area stretching from near the northern margin of the Canning Basin for an unknown distance to the south. The southern "Nullagine" sediments possibly derived from the north, within the Canning Basin. It therefore seems likely that in the upper Proterozoic large areas of the northern and southern parts of the Canning Basin were actively eroding. By Lower Ordovician times the northern area at least had submerged and the areas of deposition of the Kimberley Plateau and the "Nullagine" sediments were probably land masses contributing sediment. If similar Upper Proterozoic sedimentation had taken place in the central part of the Canning Basin it is likely that that unit, too, would have emerged, and like them remained elevated and eroding to the present day. It seems most likely, therefore, that the floor of the Canning Basin is very largely of the older pre-Cambrian folded, metamorphosed and granite-intruded rocks, and that the Palaeozoic sedimentation, starting at latest in the Lower Ordovician, covered much of the Basin and was interrupted by only minor emergencies (Traves *et al.*, 1956). The shape of the floor of the Canning Basin is practically unknown, and some individual downwarps in it may be sufficiently large to warrant separate

names within the basin as a whole. First to have been so named is the Fitzroy Basin which lies between the Kimberley Block and the "Fenton Fault," the latter a feature of much importance and upon which more geophysical work is required. On the surface it is seen as a line of springs near Jurgurra Creek and passes to the south-east through Mount Fenton: it is not a continuous line and it is difficult to say where this structure begins and ends, but as a "line" it extends for more than 150 miles. In fact, it has yet to be determined whether it is indeed a fault or primarily a shelf edge which has experienced only secondary faulting. If the latter, then its continuation eastwards in the direction of Godfrey's Tank and its extension to the south must be regarded as crucial points in elucidating any petroleum prospects in the Canning Basin. A gravity profile which has been run across this "fault" indicates a "downthrow" or depression to the north, of 1200 feet near Mount Fenton, and no displacement at Jurgurra Creek; this may indicate that the "Fenton Fault" is a fault-controlled depression forming the southern side of the Fitzroy Basin, or, more likely, it represents the northward extension of a southern shelf-type pre-Cambrian sediment which would grade into deeper-water sediment in the Fitzroy Basin. The Geophysics Section of the B.M.R. carried out airborne magnetometer investigations during 1954 and 1955 across the Canning Basin. These indicated "depressions" in the basement which may contain 10,000–25,000 feet of sediment: the "depressions" are separated by "ridges" which trend west-north-west and which may have only between 2000 and 3000 feet of sediment. Light may soon be thrown upon this problem, for during August 1956 "Wapet" began drilling about 20 miles south-east of Broome with a mobile rig leased from the B.M.R. to a planned depth of 4000 feet in the first stratigraphic test of the sub-surface of the Canning Basin.

Pre-Cambrian rocks outcrop in many places in the Pilbara Block, *i.e.* along the south-west border of the Canning Basin. Gibb Maitland divided them into three units which today have become known as: (i) The Nullagine system; (ii) the Mosquito system; (iii) the Warrawoona system. The first consists of "a series of sedimentary rocks, quartzites, grits, conglomerates and shales together with a series of interbedded volcanics;" the second of "a series of grits, shales and fine conglomerates which underlies the strata of the Nullagine Series;" the third of "(*a*) altered sedimentary series of quartzites, conglomerates, quartz and mica schists, etc., and (*b*) metamorphic igneous rocks, greenstones, magnetite and serpentinous schists, and more or less altered sheared basic igneous rocks."

To the Nullagine system he gave a tentative age of Cambrian and correlated it with the sediments of the Kimberley Plateau, of which the King Leopold Ranges are a prominent feature. Since then most writers have referred to the Nullagine system as "Proterozoic" and the more metamorphosed sediments which uncomformably underlie it as "Lower Proterozoic" or "Archaeozoic." Subsequent fieldwork by the B.M.R. in the Kimberley District and in the Northern Territory has enabled them to place the Kimberley Plateau sediments as "Upper Proterozoic" and, possibly, even into the base of "Lower Cambrian." The metamorphosed rocks which lie unconformably below, such as the Halls Creek Group (Traves, 1955), are placed in the Lower Proterozoic.

The south-west part of the Canning Basin cannot be considered as a source of oil because the base of the formation is exposed nearly everywhere. Nevertheless, the Palaeozoic and Mesozoic sediments on the southern edge do indicate the possibility of source rocks for oil in the basin proper. Moreover, the sub-horizontal dips and the thinness of the unit suggest that the southern part of the basin is shallow.

Referring to oil prospects in general, the B.M.R. reports: "It is important to know whether the pre-Cambrian underlying the Canning Basin sediments (outside the Fitzroy Basin) has been continuously submerged or whether it has undergone only shallow transgressions during Permian and Mesozoic. Fossils and lithology studied in the south-west and, more recently, in the north-west Canning Basin show that a shelf-type environment existed in Permian time. The centre of the Basin is covered by sand and Mesozoic and Permian sediments, and the behaviour of the pre-Cambrian basement in Palaeozoic and Mesozoic time can only be surmised in a very general way. If it was a continuous area of deposition rather than denudation it would materially enhance the petroleum prospects of the Canning Basin. A magnetometer profile drawn across the Basin, showing 300-gamma increases over 10 to 20 miles, could be interpreted as showing either a considerable depth of sediment over a changing pre-Cambrian basement, or a thin sedimentary veneer over a uniform basement."

Further detailed geophysical work or exploratory drilling is needed to achieve an accurate picture of the pre-Permian geology of the central and south-west Canning Basin. Nevertheless, a great deal has been learnt since boring by a private company began in 1922 near Mount Wynne. By late 1956 altogether nineteen bores, totalling approximately 66,000 feet, had been drilled; the deepest was 12,915 feet near Grant Range, and the total includes three shallow bores drilled by the B.M.R. purely for stratigraphic information south of the Fitzroy River. All company bores penetrated the Upper Palaeozoic except near Prices Creek where Ordovician was reached, and at Fraser River which began in the Mesozoic.

My personal knowledge of the Canning Basin dates back to 1923 when Richard Yockney and I camped near Mount Wynne during our journey from Winton (Queensland) to Broome. At that time someone had hung a white elephant on the derrick of the oil bore there. For the sake of the whole Commonwealth, particularly in view of the situation in the Middle East, one trusts that that symbol in no way indicates the ultimate in the programme which (perhaps in rather grim determination) oil companies are pursuing in the search for oil in commercial quantities in this part of Australia. During the last thirty years I have revisited the north-west portion of Australia a number of times, particularly during my expeditions of 1928, 1932 and 1933. The heart of the Canning Basin, at least before it was photographed from the air, exercised a special fascination for me—if only because of its seclusion and aridity, wherein, similarly to the freak area which we found on its eastern border in 1933 and named "Hidden Basin," there was the tantalizing possibility of an oasis of "better country," even a mineral deposit, deep in the inhospitable sandhills. This interest, backed by much practical experience, has provided one with a good general knowledge of its geology and general conditions. But it has not been possible in the space allotted to deal fully with the flora, fauna, topography and other characteristics of these dry lands. The numerous publications listed below will facilitate that. Nevertheless the purpose, if achieved, has been to make of this paper a general work of reference concerning the Canning Basin and to place its history and affairs in correct relationship and perspective. Yet in this one's own knowledge has had to be considerably reinforced and this has been possible only through the courtesy and very considerable cooperation of the following sources of information. I am especially grateful to the Bureau of Mineral Resources for the use of certain illustrations.

Personal acknowledgements

Casey, J. N., Bureau of Mineral Resources, Canberra.
Ellis, H. A., Government Geologist, Western Australia.
Hicks, E. W., Secretary, Department of Air, Melbourne.
Knife, C. E., Ampol Exploration Ltd., Perth.
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THE USUN APAU PLATEAU

GUY ARNOLD

AN OXFORD EXPEDITION went out to Sarawak in July 1955 to spend six months exploring and surveying in a remote part of Borneo, in one of the last genuinely unexplored parts of South-east Asia. The Usun Apau is an old volcanic plateau at the head-waters of the Rajang, Sarawak's largest river. Until 1951 its existence was unknown but in that year an expedition organized by the Curator of the Sarawak Museum, Mr. Tom Harrisson, discovered this extensive upland area. Mountainous, thickly covered by jungle and giving rise to many waterways, the Usun Apau is uninhabited except for a few groups of nomadic Penans. It remained unknown for so long because all the rivers flowing from it pass through great series of cataracts and gorges, falling 1000 feet or more before reaching the navigable stretches of water nearer the coast. The expedition planned to spend six months in the area of this plateau carrying out a general scientific survey. There were four members and the work to be done included: geological survey; zoological collections; forestry survey and collections; archaeological excavations; ethnological study of the nomadic Penans; general surveying; meteorological observations; filming; the collection of soil samples. Due to the remoteness of the plateau the major problem confronting the expedition was that of supplies, but this difficulty was largely overcome by two airdrops with a three-month interval between them. The expedition is most grateful for the support given to it by the Royal Geographical Society, Oxford University, the Sarawak Government, Sarawak Oilfields (Shell) Ltd., as well as many other societies and commercial concerns.

The area covered by the expedition was extensive, ranging from the fertile and historically important Plieran valley in the south, across the more barren volcanic plateau, to Kalulong mountain in the north. About 8000 specimens—zoological, botanical, archaeological and geological—were collected as well as a selection of Penan goods. These have been distributed in various museums and are being worked on. The work of the expedition can really be divided into two—the collections for scientific comparison purposes and the surveying and the archaeological and ethnological studies throwing some light on the early history of the Usun Apau.

The Oxford Expedition was the fourth party to work on the Usun Apau and in the Plieran valley. Some of the ground covered was completely new but much had been visited in 1951, 1954 and April 1955. The Usun Apau was first brought to light when Mr. Tom Harrisson and Mr. David Leach, Director of Sarawak Lands and Surveys (since retired), made the journey mentioned above from the upper Baram to the Plieran and then down to the Rajang, in 1951. They found that a blank on the map of 1600 square miles was in reality an upland area of mountains, plateau and deep river valleys. They were the first Europeans to cross the Usun Apau and contact the Plieran Penans, and Mr. Harrisson discovered the existence of old longhouse sites, and so revealed the historical importance of the area.

In 1954 a combined geological expedition composed of Dr. G. Whittle of Colonial Geological Surveys and Dr. H. Kirk of the Sarawak Geological Surveys went into the Plieran valley. An airdrop of supplies was made to them at Long Luar—the junction of the Luar and Plieran rivers—where they had cut a clearing. Subsequently the Oxford Expedition used this site for its base camp and the first supply

drop. This geological party worked in the Luar and Plieran river areas and on the Batu Bora mountain range.

In April 1955 Dr. C. Bowen of Sarawak Oilfields (Shell) made a trip into the Plieran and worked much further up that river towards the Indonesian border.

The Oxford Expedition, 1955

The Oxford Expedition followed in July 1955. We are indebted to Mr. Harrisson, Dr. Whittle and Dr. Kirk as well as to Shell for putting their maps and information at our disposal. Thanks to their work, we began with a knowledge of routes, of the locations of longhouse sites and of the geological features of the

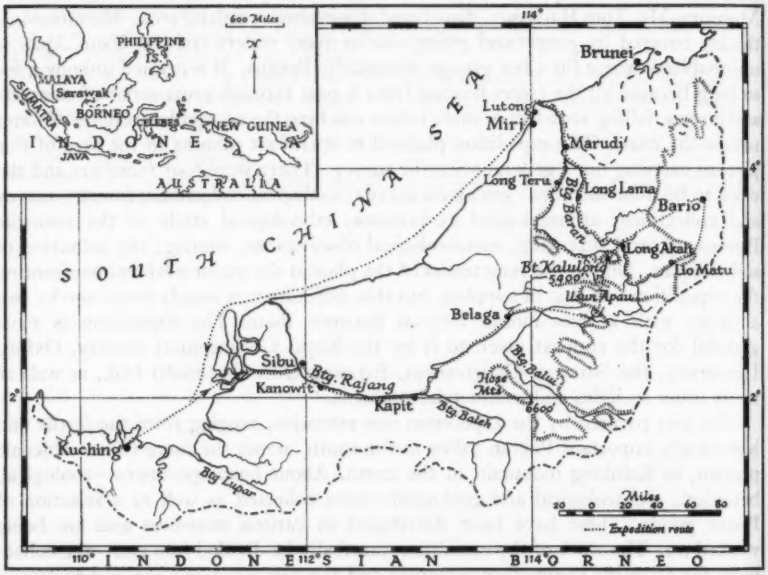
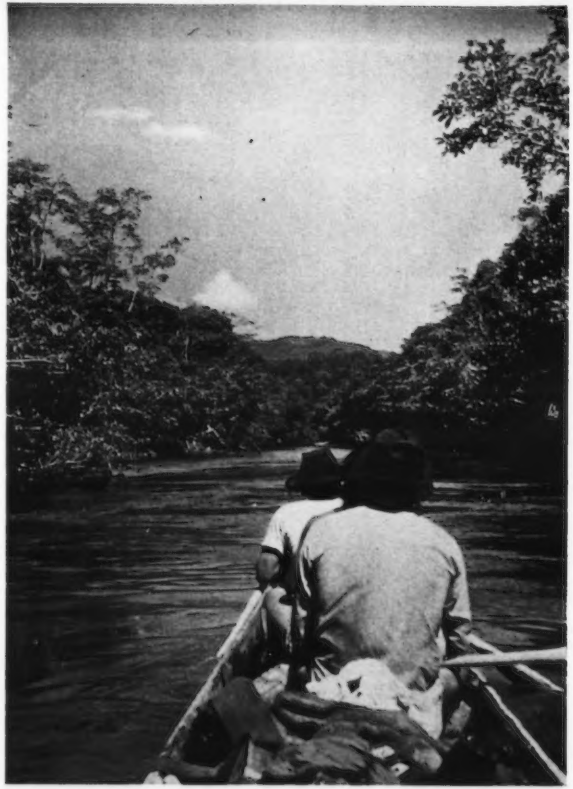


Figure 1

area—for example, the presence of coal in the upper Plieran—and this provided us with a basis upon which to start our own surveys.

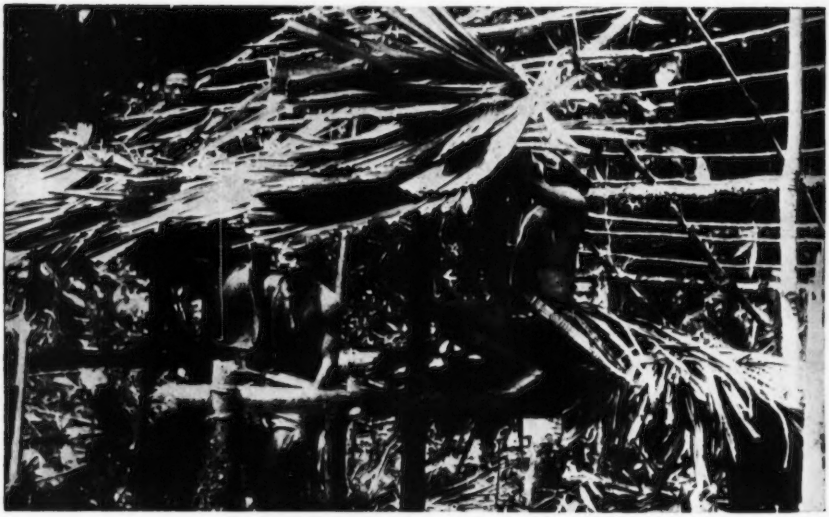
To reach the Usun Apau the expedition journeyed for three weeks from Kuching into the interior. The first part of this journey was by launch up the coast to the Rajang river and then up the Rajang as far as Kapit. From there onwards, rapids made it impossible for the launch to go any further so we transferred to large covered canoes driven by 25 horse-power outboard motors. Several more days of travel in these brought us to the point where we had to walk through the jungle to the plateau. Belaga was the last Government outstation along the Rajang at which the expedition called, and here arrangements were made to relay wireless messages to the coast. Two days' further river journey from Belaga was a large Kayan longhouse, Long Murum, where seventy men had collected to act as porters on the week's walk through the jungle to the Plieran river at the south of the Usun Apau. Sufficient supplies to last the four members of the expedition and

The first airdrop at Long Luar



Canoeing up the Plieran river

The Usun Apau plateau, from the south



Kayans hut-building at base camp

their six native assistants for three weeks—until the time of the first airdrop—had to be carried to the Plieran and half of the seventy porters were enough for this. The remainder brought rice to feed the others. Travel in the Borneo jungle is dominated by the rice equation. One man can carry enough rice to feed himself for thirty days but normally will porter half this amount and make up his load

Figure 2

with other equipment. Thus fifteen days is about the maximum time a party can travel without picking up fresh stores unless an advance system of relays is used to store rice along a route. When we reached the Plieran, twenty of the Kayans were retained as a permanent porter force and the remainder were paid off.

The expedition had two main base camps and an airdrop of supplies was made to each of them. The first was situated at the junction of two rivers; the Luar flows southwards off the Usun Apau plateau into the Plieran, and the Plieran flows due west to the Rajang. The first three months of fieldwork were to be spent working

in the Plieran river valley. Along it live groups of the nomadic Penans, and here were found the old longhouse sites of the Kenyah people who now live further north on the Baram and Tinjar rivers. At the end of this three months all the zoological and botanical specimens, rocks, and finds from the archaeological diggings, were carried out in relays to the Rajang and sent to the coast while at the same time a path was made across the plateau to the north where a clearing was cut in the jungle for the second airdrop and new base camp. The first camp was at a height of 1600 feet, the second one at 3300 feet. The new camp was 4 miles in from the northern escarpment of the plateau. Its approximate location had already been decided before the expedition left Kuching but the exact position had to be wirelessed out for the Royal Air Force; to send this message a special journey had to be made to the Baram river, then down to Marudi the nearest Government station with a wireless.

The method of work which we adopted was as follows. After the first airdrop and while based on the Plieran river the four of us worked separately for periods of one month at a time away from the main camp. The forester and the zoologist established subsidiary camps around which they collected animal or botanical specimens. All the porters and Penans would be employed to carry in their stores, then they would remain with a skeleton staff until they were ready to return with their collections to base. The other two members of the expedition, engaged on geological surveying or ethnological and archaeological work, kept more on the move and each had a permanent staff of about nine porters. At the end of these periods we returned to base for fresh supplies. A month was about the limit that could be spent away from base and so long a period was only made possible by relaying stores and through the help of the Penans acting as extra porters. Travel was by canoe along the rivers, or on foot. We borrowed canoes from the Penans but also made two large ones of our own, both designed for use with an outboard motor.

The two airdrops, each bringing supplies for three months, were totally different in character. They were made by the Royal Air Force (to whom we are greatly indebted) which on each occasion sent a Valetta aircraft across from Singapore to pick up the stores in Kuching where we had divided them into two equal lots. The first airdrop was made to the expedition as soon as it was established in the Plieran valley. The stores dropped included sufficient bulk rice to feed thirty-five men for three months, tinned foods, chemicals for preserving zoological and botanical specimens, medicine, ammunition for collecting and hunting purposes, a small outboard motor and fuel. The aeroplane made a total of three sorties on two successive days dropping thirty-nine parachutes in all. It had been an anxious time waiting and everything depended upon the drop which was the climax of our journey into the interior. Only after it had been successfully completed could we begin the work for which we had come. The Kayans and Penans were tremendously excited on the day. Some of them had not seen an aeroplane before and the Penans had gathered from all their nearby jungle settlements to watch. While the expedition was on the Plieran, porters were all recruited from the Kayans of the upper Rajang; on the northern side of the Usun Apau we recruited porters among the Kenyahs of the Baram. The Kayans are essentially a water-travelling people living along the great rivers and going everywhere possible by canoe. Since the war the outboard motor has become extremely popular far into the interior and our porters were considerably impressed when they saw one being dropped by parachute into this remote jungle. Though only a 5-h.p. motor it was of great service to us in the Plieran, for our camp was in the centre of twenty or more miles of

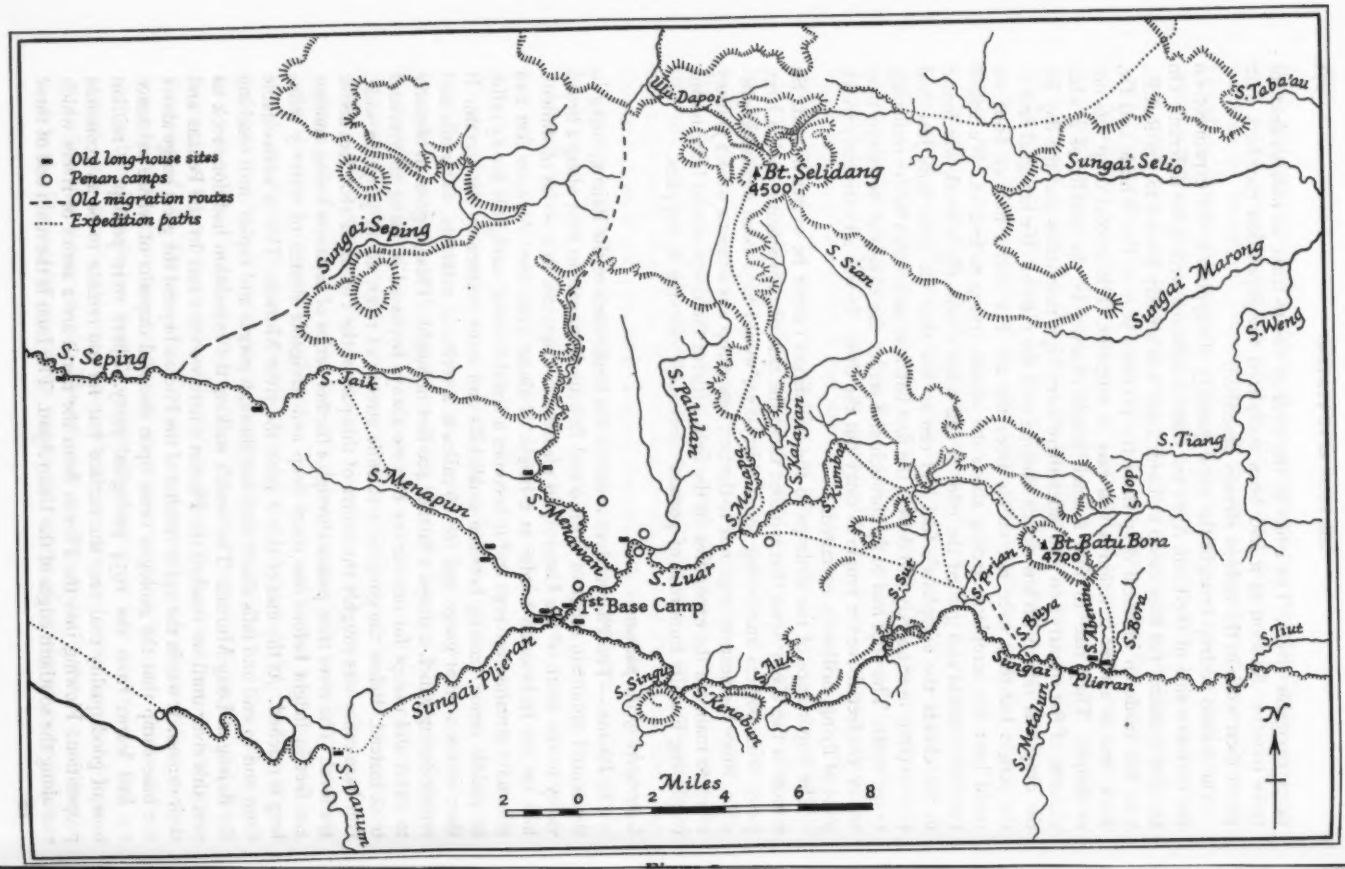
deep, navigable rivers. The effect of the airdrop was to make us independent for three months. As soon as it had been completed the expedition members went about their work in the fashion already described.

The second airdrop brought the same quantity of supplies to the expedition on the northern side of the Usun Apau but there conditions were quite different. On the first occasion the base camp at Long Luar was already known to the R.A.F., who had made an identical drop there the previous year to Dr. Whittle and Dr. Kirk, and as a river junction it was easy to pinpoint. The second drop was not so simple. They had to find a small jungle clearing in the middle of a wide expanse of flat country; on two sides there were high mountains and the day for the drop was rainy with low clouds hanging over the plateau. We lit signal fires in the jungle but they were not visible from the air. For nearly half an hour we could hear the aeroplane circling above the clouds trying to find us. We talked over the wireless and guided the pilot in and when eventually a break was found in the clouds the aeroplane's fuel had run so low that the pilot only just had time to circle over quickly and deliver the first batch of parachutes before returning to the coast. The pilot had to fly through and under the clouds at not more than 200 or 300 feet above the jungle to carry out the drop. It was an extremely tricky piece of flying, brilliantly executed.

The importance of the airdrops to the expedition cannot be overestimated. So remote is the Usun Apau that without them the task of provisioning such a large party, with porters numbering about thirty-five, would have been almost impossible. Since the nearest longhouse to the first base camp was almost a week's journey away, to maintain the expedition in the field without the drops would have meant employing literally hundreds of porters continually carrying in supplies.

Geography of the plateau

The Plieran.—The Plieran river is one of the headwaters of the Rajang, rising in the central mountain range of Borneo and flowing from east to west along a broad valley to the south of the Usun Apau plateau. It originates in a series of difficult hills on the Indonesian border at a height of about 3500 feet. At 2500 feet two mountain streams converge and it becomes a sizeable river, navigable for 15 miles by paddle canoe, passing between small hills and some reasonably flat terrain. It then enters a great gorge and for 16 miles is a series of cataracts, waterfalls and rapids during which it drops a further 400 feet in height. This gorge is an obstacle to travel and except for one survey trip we always bypassed it, using an overland track instead. Below the gorge is a 12-mile stretch of river, about 50 yards wide. Our base camp was roughly the centre of this part of the Plieran at 1600 feet above sea level. The river then passes through a further series of cataracts losing another 200 feet in height before one more deep and navigable stretch of water 5 miles long is reached. At the end of this it joins the river Murum. This is unnavigable from end to end and falls about 1000 feet through gorges and rapids until reaching the Rajang at Long Murum. The week's walking the expedition had done took us past this river until we reached the Plieran where we were met by the Penans and their canoes. It was in the upper reaches of the Plieran beyond the great gorge above our base camp that the geologist came upon the coal deposits of whose existence we had learnt from the 1954 geological party. There were perhaps a million tons of good quality coal near the surface but far too remote to be an economic proposition. Flowing into the Plieran from the north are a series of rivers which rise along the southern edges of the Usun Apau. The Luar is the main one of these


Old long-house sites
Penan camps
Old migration routes
Expedition paths
Ulu Dapoi
Bt. Selidang
4500'
S. Taba'au
Sungai Selio
Sungai Seping
S. Sian
Sungai Marong
S. Weng
S. Seping
S. Taik
S. Palulan
S. Mengga
S. Kalayan
S. Kumba
S. Tiang
S. Menapun
S. Menawan
S. Luar
S. Jop
Bt. Batu Bora
4720'
1st Base Camp
S. Suie
S. Prian
S. Bwya
S. Abenin
S. Bora
S. Tiut
Sungai Plieran
S. Singit
S. Auk
S. Kenaban
Sungai Plieran
S. Metalun
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2 0 2 4 6 8
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and our camp was at its junction with the Plieran. Up many of these were the traces of old longhouses and much of the ground between them is flat and fertile. In the past it had supported several considerable Kenyah communities and could be used for rice growing again today.

The Batu Bora–Bilasat mountain range.—This is a sandstone range lying between the Plieran river and the plateau to the north. The main Batu Bora mountain is 4700 feet high, and dominates the upper Plieran valley. The mountain forms a great massif with sheer sides. To the north-west is Mount Bilasat forming the west end of the range while south-east is a secondary formation of Batu Bora, a great ridge 4400 feet high with a series of jagged rocks sticking out along the top like teeth.

The Usun Apau plateau.—The plateau itself is volcanic, a flat expanse of about 600 square miles dominated in the centre by three extinct volcanoes: Selidang 4500 feet, Kenawang 4200 feet, and Mabun 4200 feet. Selidang is geographically the centre of the plateau which averages about 3500 feet in height. The northern, eastern and western edges of the tableland end in sheer escarpments of nearly 1000 feet and along the northern edge three rivers tumble off in 800-foot waterfalls. The largest of these falls was used as a landmark by the Royal Air Force when they came with the second airdrop of supplies. The plateau is split in two by a steep-sided valley, the Dapoi, running due north from Selidang: possibly this valley was a volcanic lake. Four miles north of Selidang is the second extinct volcano, Kenawang. The Dapoi river heads westwards from Selidang for a few miles then turns north and leaves Kenawang to the east. The third volcano, Mabun, is on the western side of the Dapoi so that with Kenawang they appear like sentinels on either side of the valley. The river cuts a deep gorge through the northern escarpment and then flows into the great Tinjar tributary of the Baram. The western tableland of the plateau, dominated by Mabun, is only about a third the size of the eastern tableland. Along either side of the Dapoi valley is a chain of mountains, some 4000 feet high, and among them originate the streams that flow north and east across the plateau. Along the top of the escarpment are many small hills covered with a peculiar mixture of primary and *kerapa* or *kerangas* jungle. Travel in these hills was extremely difficult though in the flat centre of the plateau it was relatively easy; on the journey across the plateau, to establish the second base camp, it took ten days cutting all the way to cover 25 miles. *Kerapa* is a peculiar form of stunted jungle growth quite common in some of the upland areas where the expedition was working. It is due to poor soil and bad drainage and the result is low, small trees with gnarled trunks and huge roots reaching far over the ground. *Kerangas* is another type of jungle, found on volcanics; the trees are tall but have very thin trunks and it is not a luxuriant growth. From the western tableland flow the rivers Belaga and Seping, draining into the Rajang. From Selidang to the east runs the Selio river, a tributary of the Baram. All the rivers originating on the Usun Apau either cut deep gorges through the escarpment or else go over in sheer drops. The southern edge of the plateau has no definite escarpment; instead, there is a series of long finger-like ridges with deep valleys between them down which the Luar and other rivers drain into the Plieran. The three extinct volcanoes, Selidang, Kenawang and Mabun, form a triangle in the centre of the plateau and between them clouds gather so that the Dapoi valley receives enormous quantities of rain. Its sides are extremely steep with literally hundreds of streams rushing down into the Dapoi river. Consequently, this river has a phenomenal rise and fall and during heavy rain the water level would rise as much as 20 feet

within the space of two hours. One of the rivers originating near Selidang which flows north across the Usun Apau is the Julan. It falls over the escarpment in a sheer drop of 800 feet, and 4 miles in from this fall the expedition established its second base camp. Along this river below the escarpment the geologist found a rock specimen containing significant quantities of gold and in consequence further investigations are being carried out there this year by the Sarawak Geological Department.

Mount Kalulong.—Ten miles north of the Usun Apau escarpment is Kalulong, a great twin-peaked granite mountain. It was first climbed in 1932 by members of the previous Oxford Expedition to Sarawak and had not been approached since until two members of the present expedition climbed it and collected specimens there during the last month of our fieldwork. Beyond Kalulong the Baram river, second largest in Sarawak, flows north-west to the coast and the expedition gradually gathered on the Baram preparatory to returning to the coast and Kuching. During the final month in the field we worked from Baram longhouses using them as bases for trips to Kalulong or for zoological collecting.

These were the main limits of the ground covered by the expedition (although a trip was made into the remote Kelabit plateau at the headwaters of the Baram). The zoologist had four series of camps at various heights over the Usun Apau from which he made collections for ecological comparison purposes. The forester also had camps at four selected sites where he cut plots for representative botanical collections as well as making more general forestry surveys. The geologist surveyed over the whole area while the ethnologist worked among the Penans, excavated in the Plieran valley and collected folklore among the Sebop and Kenyah people in the Tinjar and Baram rivers. Surveying was done wherever possible. The geologist mapped as he went along; heights of mountains and names were filled in, time and compass surveys were made along some unmapped rivers and one unknown mountain was put on the map. Most of the area has been photographed from the air and in view of the other work which the expedition had undertaken this general filling in of details was considered the most useful survey contribution which could be made.

The Nomadic Penans

Our first base camp was in the centre of several groups of nomadic Penans and the ethnologist of the expedition spent considerable time among them, collecting ethnological specimens and carrying out a census. The nomadic Penans are the most primitive of all the Borneo people. They live in groups of about fifty deep in the jungle, and usually avoid contact with other tribes. They will stay in one place for perhaps three months, perhaps a year, until they have driven all the game away by their hunting and exhausted the wild sago and fruit supplies of the area. Then they will move on. When our expedition arrived they were very shy, but they rapidly became accustomed to us, especially after they had seen the airdrop of supplies. Then their curiosity and desire for new things, and particularly for the tobacco they knew we had, conquered any of their remaining doubts. In appearance they varied tremendously. Some of the men were little over 5 feet tall, others as much as 6 feet. They were all powerfully muscled and could carry far heavier loads than the Kayan porters we had, often as much as 80 lbs. The Penan girls are very pretty in their teens but, with hardly an exception, age very quickly after twenty with childbearing, sickness and hard work. Each group named itself after the river on which it lived and they moved as often as their hunting needs

required. They prefer the shadows and avoid the sun's rays, frequently complaining of the heat. They refused to cut the clearing for the airdrop to the expedition as this would mean working in the sun. Their skins in consequence are paler than those of the Kayans or other Borneo people, and a few of them were almost white. Their settlements are made in small clearings allowing no more light and open space than is necessary for the cluster of huts. A normal Penan camp had seven or eight huts to house fifty or so people, and although two or three huts would be very small the larger ones are quite spacious. Except for the roofs they are constructed entirely from saplings and small tree trunks, and the uprights, cross bars and roof frames are tied together by *rotan*.

The Penans do no cultivation of any sort. They collect the wild sago of the jungle and make it into starch food, gather wild fruits, of which there is both variety and abundance in season, and hunt wild game. As hunters they are magnificent. A few of the headmen have recently acquired shotguns, but most of them use blowpipes and spears, while each settlement has twenty or thirty dogs. The men hunt continually—wild pig, deer, monkey and any other game they sight, even an occasional honey bear or clouded leopard. Poison darts are used for pig and have a paralysing effect after a few minutes; the animal cannot run, but is brought to bay by the dogs and then speared to death. A Penan can judge the effect of wind exactly on a 10-inch dart from his blowpipe and aims accordingly. Once a young pig was caught alive. A hole was made in the sinews of the hind leg and a long piece of *rotan* attached to it. Then it was allowed to run so that the young boys could practice spearing. They excel in jungle law over all the other Borneo people, travelling extremely fast and noting signs and sounds undetected by anyone else. The Penans, living a nomadic jungle life instead of in settled village communities, are looked down upon by the other Borneo people and our Kayan porters referred contemptuously to them as "men of the jungle." Consequently they were always trying to explain in their stories why they were different from the other Borneo tribes. They were quite unreliable and sometimes liars, dirty, petulant and wearyingly persistent cadgers, yet humorous, strong, attractive and very friendly.

Archaeological excavations

Along the Plieran and tributary rivers were a total of fifteen old longhouse sites and trial excavations were made at eight of them. Most of these sites were a hundred years old though some were less. The number and variety of finds varied considerably from longhouse to longhouse. They included beads, porcelain, pottery and glass fragments, iron implements, iron slack, stone work and one or two miscellaneous objects including a gold hair ornament. These longhouses had belonged to Kenyah and Sebop people now living further north in the Tinjar and Baram river areas. They had lived in the Plieran valley until early in the 1880's when a great Iban raiding party went up from the Rajang and drove them out with considerable bloodshed. Along the upper Plieran were the traces of wide paths which had been used by migrating Kenyahs coming across into Sarawak from old Dutch Borneo. Some of these longhouses were probably only temporary settlements of migrating people while others were established communities who had been there for many years. Several of the houses were over 300 feet long and some of the upright piles still remained in the ground. Judging by the number of specimens found they must have been wealthy communities and the fragments of Chinese porcelain indicate an extensive trade down the Rajang towards the coast even from this remote area. Most sites produced iron slack so they must have

worked their own iron. Around all of them was extensive secondary jungle growth the result of many years *padi* planting. Kayans and Kenyahs who accompanied the expedition said that some of the land along the Plieran, Luar and Menawan rivers would yield a better rice crop than the areas where their longhouses are today, but in modern Sarawak the Usun Apau is too remote for the average longhouse community to want to settle there. Journeying down the Tinjar after we had left the Plieran valley and moved to the north the Sebops told many stories about how they lived on the Usun Apau before being driven out by the Ibans. Moreover they said they had been there for many generations and that the legendary mountain Batu Kinsiang where they claimed to have originated was situated somewhere near the upper reaches of the Luar. Thus, although now only inhabited by a few groups of nomadic Penans, a century ago the Plieran valley must have been a thriving centre of Kenyah life as well as a major migration route from East Borneo.

DISCUSSION

Evening Meeting, 7 January 1957

Before the paper the PRESIDENT (General Sir JAMES MARSHALL-CORNWALL) said: Our lecturer this evening is Guy Arnold, the leader of the expedition which went out to Sarawak in August 1955 and did valuable work in a comparatively unknown area. The leader and all members of the expedition were graduates of Oxford University. The leader himself took Honours in history, which is not a bad background for a leader of an expedition; the other three members were a zoologist, a geologist and a forestry expert. One of my respected colleagues on the Council of the Society recently in this forum denounced the habit of having "'ologists" of any kind attached to expeditions. I disagree: I think expeditions derive great advantage from scientific support and having scientific objectives and I am glad that this evening we are to hear the leader of an expedition which included "'ologists"—a zoologist, a geologist, an ethnologist and a forestry expert in his party. The expedition is in my view all the better for having had those ingredients. The expedition to Sarawak received the financial support of the Royal Geographical Society and of the Geographical Magazine Trust Fund (which has done so much in the past in supporting University exploration) and was sponsored by the Oxford University Exploration Club, the oldest University Exploration Club in existence, started thirty years ago and arrived now at the age of discretion. We are fortunate in having with us this evening the President of the Oxford Exploration Club, Dr. Kenneth Sandford. This expedition is a good expedition of its kind—a University expedition. We want to encourage our young men to go out and explore the remaining unknown parts of the world.

Mr. Guy Arnold then read his paper

THE PRESIDENT: After listening to that wonderful talk and seeing the beautiful pictures my first reaction is a feeling of satisfaction that our Society in a small way contributed to the success of that worthwhile expedition to a distant and comparatively unfamiliar region of our dwindling British Empire. My second reaction is a conviction, a firm conviction, that the "'ologists" proved their merits in spite of my distinguished friend on the Council with whom I frequently disagree. At any rate, the geologist apparently sold Sunlight soap quite successfully to one of the local girls and probably he has now qualified for a job with the Empire Marketing Board. My third reaction is to congratulate the Oxford University Exploration Club on the good work they are doing by supporting expeditions of such a nature. As I said earlier, that Club is the oldest of its kind in this country and we happen to have on our Council two distinguished members of it, Sir George Binney and Captain A. R. Glen, who have both done good work in exploring the Arctic. Also we have with us this evening as our

guest, Dr. Kenneth Sandford, the President of the Oxford University Exploration Club and Reader in Geology in the University of Oxford. I now ask Dr. Sandford to say a few words.

Dr. KENNETH SANDFORD: First, I would like to congratulate Guy Arnold on this extraordinarily successful expedition. It was a fine performance amazingly carried out, and this evening we have listened to a fine lecture. Secondly, may I say a few words about the expedition as we saw it in Oxford. The first I heard of it was in a letter from Guy Arnold, who was away from Oxford, saying that he proposed to go to a remote part of Sarawak, adding that the expedition would mean an expenditure of some thousands of pounds. I did not take that very seriously because "some thousands of pounds" in a Club which had no income did not seem very probable. However, quite soon he returned to the charge, by which time he had recruited others who thought in the same way as he did. So by force of numbers, let us say, one had to take this matter seriously because he wished to carry out the expedition with the support of the Oxford University Exploration Club. So we went to the next stage. The first stage had been his idea; the second had been his recruiting of similarly minded people to make a good party of "'ologists." So we proceeded to the organization stage. I watched Guy Arnold with immense interest as he went through the phases of the planning of an expedition—detailed plans, equipment, food and resources. As to the plans, he will long since have forgotten some of the early forms. Every expedition has innumerable plans which do not happen: it boils down to those which may happen, and in this instance did happen. It was a most thorough business, so thorough that Guy Arnold thought it worth his while to fly out to Sarawak to interview the officials in Kuching who might be able to help him, and in fact did help him very much.

After that the expedition was well founded. We passed on, and I watched the stage of equipment and food and resources. And here I would like to mention the astounding generosity of firms of various kinds. Throughout nearly thirty years I have seen this generosity manifested each year, by firms who take untold interest in the proposed doings of young men in remote parts of the world, firms who spend money on producing things that might meet the particular problem, who supply young men with large quantities of stores free of charge. I cannot sufficiently express my admiration of the public-spirited performance of firms of every description throughout many years, in this particular connection. So we come to the question of resources, resources partly in kind from these generous folk, resources in kind from the government at the other end, together with great help from officials and others on the spot, resources of the financial sort, which I leave just for the moment. After all that, the expedition was intensely highly organized; one might say it had the right men, it had the right equipment, and that it could not go wrong unless local conditions produced circumstances which could not be foreseen. As we have seen this evening, the expedition to Sarawak was a great success. And so we are led on to the last stage, the publication of scientific results which will probably take years to complete, and the leader's particular task of dealing with the grisly subject of outstanding financial obligations, which is the overhang of nearly every expedition. In this case it seems to be going like the expedition itself, extraordinarily well.

May I, to conclude, say a word about the Oxford University Exploration Club. It was founded thirty years ago, chiefly by young graduates and undergraduates, after a series of expeditions in the 1920's. It was thought then that it would be a pity if all the experienced men were to be lost when members of expeditions scattered. So the Club was started. I want to make it clear that it is an undergraduates' club, the chairman and all the officers are undergraduates; they come and go; the part played by older members of the university is meant to be a minimum. There are one or two of us who provide the hindrance, as no doubt undergraduates sometimes see it, and the continuity and so on which we feel worthwhile. But it is their show. It has succeeded through the years. I have been most interested to see generation after generation of undergradutates come along and join in these expeditions. The Club has sponsored

well over thirty expeditions which have produced scientific results of some merit, published in innumerable journals. Pre-war expedition results have been published in bound volumes. It has been interesting to me to notice all through the years that undergraduates are exactly the same sort of people; just as independent, just as determined to do certain things. After the war just the same sort of young men came forward, and it is most encouraging as time passes to see still the same sort of people reacting and acting as they did when I knew the Club in its early days.

To conclude with a mention again of finance. This queer club run by undergraduates has no income. Each expedition must organize its own finances and we help as we can. This Society of ours has, above all, been extremely generous to university expeditions one after the other through the years and so has the Geographical Magazine Trust Fund. The University of Oxford helps and, if it is satisfied, allows an expedition to use its name. The colleges help, but let us remember that the men going on an expedition provide what they can out of their own pockets, and that is something on which we always insist—as they themselves do also. It is their financial obligation. There are other sources of help from firms and private persons who are interested. We have in the University also a trust, the Paton Trust, in memory of Alexander Alan Paton, established by his sister, which is nothing to do with the Club at all; it is administered by the University but directed towards helping approved expeditions of the Oxford University Exploration Club. That is how some of the finance is obtained, but the bulk of the money, in the end, must result from the effort of the leader of an expedition, and you will have gathered this evening that this enormous liability has been met in various ways and, I think, most successfully. So, as far as the Oxford University Exploration Club is concerned, it aims at two things in particular, continuity through the years—the continuity of intelligence, of standard, or personal contacts and all that sort of thing; it also has tried to maintain a standard of excellence in its expeditions. That is the attribute of the expeditions themselves one after the other, and we have seen tonight that the standard is very high.

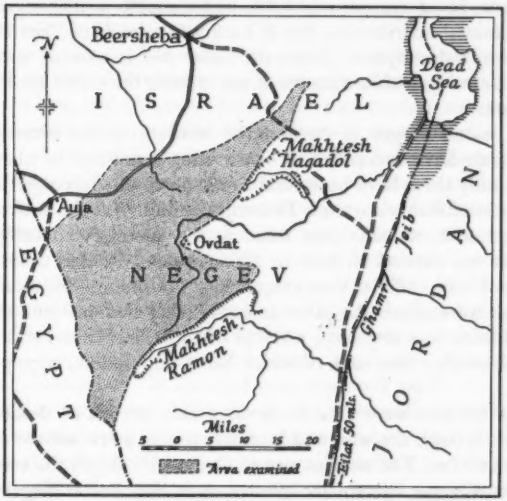
THE PRESIDENT: It only remains for me to thank our lecturer, Guy Arnold, who has retained our interest and captured our admiration throughout the evening.

WATER AND SOIL FROM THE DESERT: SOME ANCIENT AGRICULTURAL ACHIEVEMENTS IN THE CENTRAL NEGEV

YEHUDA KEDAR

IN CONNECTION WITH G. W. Murray's article on water storage and exploitation in ancient Egypt,[1] it may prove useful to record what was achieved in this field in yet another arid region and in a different historical period.[2] The central Negev lies beyond the settled land of Israel, between the steppe to the north, and the desert region of the south (see map).

During the time that elapsed between the second century B.C. and the seventh century A.D., this region, which forms one morphotectonic and climatic unit with



the Sinai Peninsula, was fairly densely inhabited[3–7, 10, 11] The settlements' prime function was, at first, to watch over the Nabatean kingdom's caravan routes and, later on, to protect the boundaries of the Roman and Byzantine Empires from the incursions of desert nomads. This *limes* protected the Negev, the southern part of Palestina *tertia*, from raids coming from the Sinai Peninsula.[8] The settlers were well versed in the wise use of water, and the remains of the agriculture which they engaged in, densely scattered over all parts of the central Negev, afford us an opportunity to judge the extent of their acquaintance with the physio-geographic conditions of the region.

The morphological elements which make up the region under discussion—the mountainous central part of the Negev—are parallel anticlinal ridges trending NE.–SW. Five of these ridges, spaced about 15 kilometres apart, are particularly prominent. As one proceeds southward, their crests grow higher, rising by 600 metres over a distance of 30 kilometres. These anticlines are breached: *makhteshim*,

or erosive cirques, have developed in the structural domes of the ridges. Largest of the *makhteshim* is the Ramon, 35 kilometres long, 7·5 kilometres wide and 400 metres deep.[9] There is a definite correspondence between the geological structure and the geomorphological features of this mountain area, built of Cretaceous and Eocene formations, while the "windows" of the *makhteshim* reveal strata going back to Jurassic and Triassic time. The anticlinal ridges are drained by a trellis pattern of streams, with the major valleys occupying the synclines while their tributaries are sometimes resequent and sometimes consequent.

The climate is arid, the maximal isohyet being 100 millimetres at the lower altitudes. It should be noted, however, that climatic maps of the region are based not on actual on-the-spot measurement but on ecological conditions and on interpolation between data collected along its margins. The characteristic vegetation consists of *Artemisietum*, *Herbae albae* and *Zygophyllum dumosi*, with occasional trees occurring in depressions and wadis at altitudes above 600 metres. The region as a whole is an average 650 metres above sea level. The rainfall also spells out true desert conditions, being erratic, unreliable and unstable in its geographical as well as seasonal or annual distribution, but if it rains it rains hard. For the rest, it perfectly fits Murray's description. Since the loessy soil is covered with a hard crust and the relief is strong, within minutes of any shower the wadis are filled with large amounts of water.

Today the central Negev is beyond the borders of the *oecumene*. Although Jewish settlements have succeeded in overcoming a number of obstacles in other parts of Israel, only three have been established here, all of an experimental nature. The only other inhabitants are a few Bedouin families. Yet the entire region is very densely covered with remains that attest to the successful development of the agriculture that was carried on here in Nabatean and Roman times under official sponsorship and with official encouragement.[10] Although physical and climatic conditions then were much the same as today, this arid and mountainous region contains, in addition to a very large number of ruins, individual and in groups, the remains of at least six cities, each of which had a population ranging between 3000 and 6000.

The ancient farmers were able to develop this stretch of desert into a food-producing area through the wise and intensive use of a few simple methods which we shall now describe. The ancient city of Ovdat (Aboda) in the centre of an agricultural district of some 130 square kilometres in the central Negev, will serve as a sample area. It was founded by the Nabateans about the second century B.C., but the traces of the first settlement are largely obliterated by Roman and Byzantine remains.

The only source of water that is available here comes from the episodic showers that fall on a maximum of some fifteen days out of the year, producing run-off that lasts for a seasonal total of twenty hours at best. It is this flow that the canals of the area, as well as its dams, were designed to capture. In this they differ from the canals of non-arid areas, where the water source is either perennial or seasonal, such as a well, a spring, or a rising river. Unlike most agriculture in desert areas, these canals did not distribute water from springs or wells but put the rainfall and flood water of desert downpours to immediate agricultural use. We deal, therefore, here not with farming in an oasis, but farming in the desert.

In order to produce the moisture required for growing crops in this desert area, and to retain the moisture at a depth available to roots, run-off from an area twelve times the size of the cultivated plot is required. In its dimensions, of course, the

irrigation network that channelled this flow cannot compete with those of the ancient civilizations of Mesopotamia and the Nile Valley. Considering the limited number of ruined sites in this area, this, however, was quite an ambitious scheme, the largest of the canals being 2 kilometres long, 6 metres wide and 2 metres deep.

Two kinds of canals were used here side by side, the first drawing its water from a barrage in the wadi bed—*i.e.* down in the valley. It is not long and it has a low gradient, but it is sturdily built, for it was generally called upon to deliver flood-water to fields of several hectares. The other type of canal has its starting point at the divide—*i.e.* high up on the valley slopes. Thence it goes down, generally across the slope, to collect the water that comes down the slope and to divert it to a given spot. Its gradient is steeper and in its upper part, where it has to carry less water, the canal is less sturdily built. Its advantage is that its length, its width and its path may be designed to fit any agricultural requirements. A canal of the first type, on the other hand, must be adapted to the local topography, which will govern both its size and its direction.

Within these two broad classifications, we may distinguish six ways in which the ancient farmers of the Negev were able to distribute the last drop of water in accordance with their needs. The canals supplying irrigation water from the bed of the wadi to land on its old fluvial terraces were generally the sturdiest. They were about a kilometre long and 15 square metres in cross-section, and carried water to lands up to 7 hectares in area. The lands, in turn, were divided into plots set stairway-fashion on the wadi banks. The water was fed to the highest plot and flooded it, after which the surplus passed on to the plot below, and so on down the wadi side until the surplus water from the lowest-lying plot had found its way down to the wadi bottom. Sometimes it was necessary to carry water not to the whole system of plots but to one of the plots only, either because it lay higher than the rest and could not be supplied in the same way as the others, or because there was not enough water to irrigate the whole system. The canals discharging this function have been found to be smaller and less sturdy. The same is true of canals serving a third function—supplying cisterns with water, generally collected from surface run-off up on the slopes and not diverted from the wadi itself.

A fourth task that canals had to do was to divert water from the catchment area of one wadi to that of another, where more land was cultivated than the basin's own run-off alone could irrigate. There are also canals built across the slope in order to divert the run-off further upstream than where it would normally drain. Finally, where a wadi had been dammed in so many places that water going through all the reservoirs in succession could not get all the way downstream in sufficient quantities, canals were dug for the very opposite purpose—short-circuiting the wadi's course and carrying the water directly from its higher to its lower reaches.

Most interesting are canals that were meant to supply not only run-off but also soil and silt. Built almost along the slope instead of across it, they collected the run-off which was rich in soil particles. This they deposited lower down to create cultivable fields in the valley behind small check-dams. This subject will be dealt with more fully in connection with the mounds in the area.

Damming was the second means by which the ancient Negev farmer was able to expand his cultivable land. He made extensive use of it in this region, investing far more effort in it than in canal building, both from the point of view of planning and with regard to the physical work involved. No less than 17,000 dams are found in our sample area of 130 square kilometres. In order to appreciate the reason for this great density of dams, it must be remembered that one of the limitations of

farming in this arid region is the lack of soil. The only natural conditions under which cultivable land is found here are the old fluvial terraces of the larger streams and the alluvial fans at the mouth of the smaller streams. Together, the cultivable land in these two categories account for only about 0·4 per cent. of our sample area—50 hectares (125 acres). So little land could never support the population of 6000 in and around the town of Ovdat, and the land problem must have been as acute as the water problem. In order to solve it, our ancient farmers dammed the course of every wadi in the area, except the largest ones, whose flow they were unable to control.

The Negev dams fall into four functional categories. The first is a barrage, diverting the run-off that it impounds into those canals that supplied water to systems of fields on the stream banks (see above). Such dams are found inside the beds of the larger wadis, and they are of respectable dimensions. In the Wadi Ovdat, for instance, there are remains of one dam erected out of big stones and built in the shape of an arc, convex upstream: it is 4·2 metres thick. There are not very many dams in this category, and they have all deteriorated to the point where it is difficult indeed to reconstruct them.

Very different was the function of the thousands of smaller dams that were built inside the small and medium-sized wadis. Here the average structure is 40–50 metres long, 1·8–2 metres high and 2–2·5 metres thick. This structure has two faces, in which the stones are set in stepped courses, so that the dam is appreciably less thick at the top than at the bottom. The space between the two faces is filled in with rubble and earth. These dams are spaced about 40 metres apart, and upstream of each there is an accumulation of silt that reaches back to the next dam, so that a continuous strip of alluvium has been created inside the stream bottom. (See plate facing p. 185.)

The main purposes of the damming, then, were apparently to force the eroded material carried by the floodwaters in suspense to settle and, at the same time, to check the flow of the water so that it could seep into this alluvium and be stored in it. In other words, the ancient farmers of the Negev built these dams in order to conserve the two fundamental elements of agriculture—soil and water. The 17,000 dams in our sample district brought about the deposition of alluvium on 700 hectares devoid of soil, increasing the amount of cultivable land from 50 hectares to 750—from 0·4 per cent. of the total area to 5·8 per cent. (in some places, the proportion of cultivable land to total basin area even grew from nil to 7 per cent. and 8 per cent.). In other words, man had expanded the area that could support human life in this arid region by 1400 per cent. and more.

Thus the ancient Negev farmer, far from surrendering to the physio-geographic conditions around him or even from adjusting himself to them, managed to gain control over them. Refashioning the hydrographic net at will, he took a hand himself in the pattern of exogenic forces by converting a denudative zone into an accumulative one—and, as we shall see later, an area of natural equilibrium into an area of increased denudation. In effect, this meant writing a new chapter in the history of the wadis. Ever since Pluvial times, they had been in the erosive stage; now they entered the stage of deposition. In some places, the wadi floor widened as much as tenfold. Today, of course, with the region deserted for 1500 years and the elements allowed to breach the dams, the streams are forsaking the constructive, leisurely course which was forced on them and have cut themselves once more deeper and narrower beds.

The achievements of the ancient Negev farmer were won through the intensive

use of resources that were severely limited when one considers the magnitude of the natural forces with which he was confronted, and the fact that those forces were working, as it were, at cross-purposes with him. In the valley of a river that regularly floods its banks at the proper season and deposits fertile sediment on them, no special power of observation is required to take advantage of these periodic and predictable inundations in order to start storing soil and have it flooded with water. Here, on the other hand, nature is not an ally but an enemy. The water is scant, the floods can never be counted on, the run-off erodes what little soil there is and its flow grinds the wadi beds ever deeper. To curb the destructive forces of nature and harness them for constructive use, required understanding, skill and extensive powers of observation. The canals, the dams, and, as we shall see later, the mounds in the area all attest to the ancient settlers' ability to realize the size of a wadi's catchment, the potential volume of the stream flow and the area of the land that could be irrigated with it, as well as the amount of soil eroded by the flood-waters. They evidently also knew the best ways of increasing the rate of erosion on the slopes while bringing about depositions in the wadi bed, where the soil could be relied upon to receive the most water, when there was water anywhere about.

The dimensions of each dam, in fact, are strictly allied to topographic conditions in the wadi across which it has been built. The length is governed by the width of the potential stream, *i.e.* the distance between the foot of the slopes. Accordingly, some dams are as much as 200 metres long while others reach barely 5 metres. The width of the dam is proportional to the volume of the water it impounds, but 1 metre seems to be the minimum. The height of the dam, finally, is that of the highest point in the reservoir—*i.e.* the bottom of the next dam up-stream. In fact, the combined height of all the dams in one wadi barely exceeds the difference in altitude between the beginning of the wadi and the dam that lies furthest downstream.

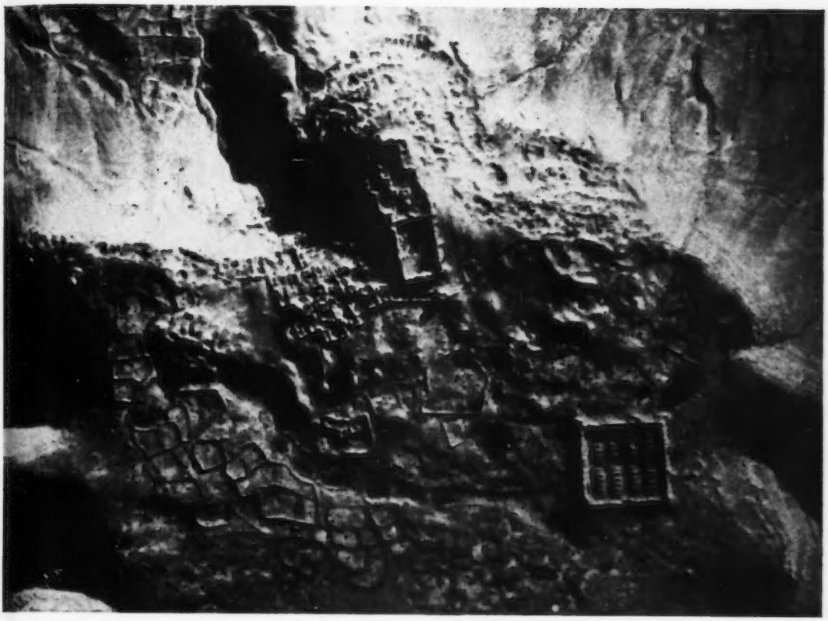
The intervals at which the dams were put up inside the bed of any one wadi are further proof of sound calculation on the part of the builders. Had the dams been twice as high and twice as far apart, for instance, the deposition of alluvium throughout the length of the bed would have required at least four times as much eroded material, and this over a period at least four times as long. In addition, at least three times as much work and material would have had to be invested in the construction of the dams. We did not find it possible accurately to determine the time that elapsed between the damming of the stream bed and the beginnings of agricultural activity. At any rate, the amount of work which the damming entailed was so great that we surmise a man would not want to carry it out unless he expected to reap the results in his lifetime. To create one particular plot of 3 hectares, for instance, the builders had to erect a fence all around it and dam the stream bed in a dozen places. The combined length of these structures is 860 metres, and their combined volume, 3000 cubic metres of stone. The number of workdays all this called for is a matter of conjecture, and we do not have enough data on the social structure of these ancient settlers to come to far-reaching conclusions, but two facts can be established. One is that the creation of cultivable land never stopped until water and soil had been provided for all the potential cultivable space; in other words, in our sample district, the 5·4 per cent. of the area that was actually reclaimed represented the sum total of all space for which soil and water could possibly be secured. The other fact, to which we shall return later, is that canal building and damming could not have been the only process creating agricultural land, as they cannot possibly account in themselves for all the soil that was in fact deposited on the reclaimed land.

Complementary to the dams which brought about the accumulation of silt in stream beds were those that were designed to hold up in stepped artificial banks the soil of fluvial terraces. While the former were built on gravelly subsoil in order to create cultivable land, the latter were erected on alluvial subsoil in order to conserve cultivable land that was already there. It is likely that they were the first ones to be put up, since the farmer could immediately proceed to cultivate the land which they protected, while building dams inside the wadi bed meant years of waiting until sufficient silt had accumulated behind them to make cultivation possible. The dams on the banks were not of great moment to this agriculture: the land which they protected made up only 7 per cent. of the total cultivated acreage in our sample area. For the farmer, however, the soil which they held up presented several advantages over the silt in the wadi beds. Being thicker, it stored more water, and was also better suited to the growing of deep-rooted crops; and since it was generally found on the fluvial terraces of the bigger streams, it was assured of a more reliable supply of run-off than land inside the smaller wadis. Rainfall, we must remember, is so erratic in this desert area that the chances of flow in a wadi are directly proportional to the size of its catchment area. Although soil conservation was the prime function of this category of dams, their use incidentally resulted in two equally important by-processes: flooding, the only irrigation method that is practicable here, and the deposition of alluvium, whose fertilizing function also deserves special mention. The last of our four categories of dams are small and have an ancillary function only—to break the erosive force of water streaming down the gullies and threatening to destroy canals, fences, etc.; and to force the sediment to be deposited inside the gullies, behind the dams, in order to save the canals from silting up.

One last remark: every dam has a spillway. None of the dams in the central Negev were designed to impound the run-off entirely, but rather to delay its flow in order to encourage deposition and seepage, and to transfer water from one place to another. There are only isolated instances of storage dams.

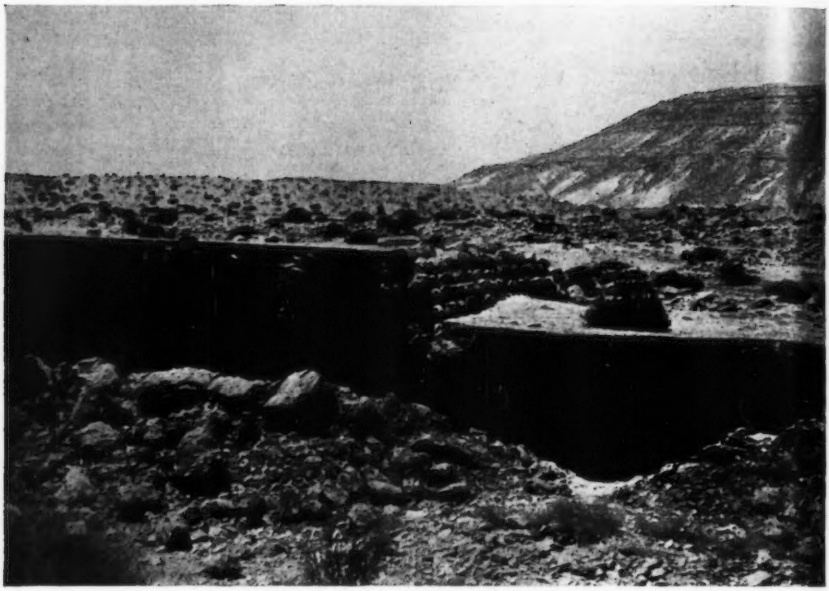
While everyone recognizes the various purposes for which the canals and dams in the central Negev were built, opinions are divided on the function of the third class of remains there—rows upon rows of stone mounds on the hill slopes. Investigators are agreed only on the correlation of these mounds with the cultivated valleys, which are never very far below, and on their apparent consequent connection with agriculture. The mounds are small and round, consisting of stones heaped or laid to a height of 70 centimetres and a diameter of 1·5–1·7 metres. The stones are of the same kind as the ones that happen to litter the ground in the immediate vicinity—limestone, flint, or any other rock. There are hundreds of thousands of these mounds in the central Negev. In the Ovdat district they occupy 2500 hectares out of a total area of 130 square kilimetres. This is three times as much space as the 750 hectares that were devoted to cultivated land. They are invariably found on slopes above the cultivated valleys, but never inside the valleys, and they never occur singly but always in groups, their number rarely departing from an average of eighty to the hectare. They are laid out in perfectly straight rows, with shallow canals or raised furrows running down between every row and the next. On an aerial photograph, the pattern resembles a mosaic or a geometrical design. The direction of the rows is almost identical with that of the slope. The canals, which lead down into the cultivated valleys, are the ones that were mentioned at the end of our section on canals as carrying eroded soil as well as run-off.

As has been said above, investigators disagree about the agricultural function of the fields of mounds. Some believe that they were all vineyards, finding support



The ancient city of Ovdat (Aboda) from the air: scale approximately 1:10,000

Smaller dams built in wadis: scale approximately 1:4000



Examples of wadi dams, described page 182

for their view in the Arabic name for these fields, which is *tuleilat el 'anab* or *rujum el kurum* (vine mounds). Others, who share this view, explain that the mounds were meant to exert a microclimatic influence. Others yet believe that the mounds are simply heaps of stones removed from the area in order to prepare it for cultivation.[11] All these views overlook the fact that the average annual rainfall in the entire region where the mounds are found is below 100 millimetres. This is far from sufficient to grow grapes, or any other fruit, without irrigation. Any possibility of irrigating the fields of mounds, on the other hand, must be dismissed in the light of what we know about the water resources of the region then as today. The mystery of the mounds will be solved, however, if we consider it in conjunction with another puzzle—the origin of the prodigious amount of eroded soil that was washed down into the wadis and created cultivable plots behind the dams when man began to modify conditions of natural drainage. The bed of one wadi section, for instance, with a catchment area of 54 hectares, has been found to contain 20,000 cubic metres of alluvium; into another, draining 73 hectares, have been silted 24,500 cubic metres; another yet, with a catchment area of 30 hectares, has accumulated 2600 cubic metres.

It has been calculated that at the yearly erosion rate of approximately 0·8 millimetres which can be taken as average in these regions,[12] the men who dammed the wadi beds would have had to wait for four centuries before the soil on their newly-created fields was deep enough to grow anything on—if they had depended on nature alone. To build a sufficient soil column inside the wadi within ten years of the damming would require a yearly erosion rate of 32·8 millimetres, which would be fantastic indeed under natural circumstances.

This is where the mounds come in. They were created when man decided to speed up the processes of natural erosion. In order that the slopes should supply him with run-off water and soil, he opened the desert pavement and broke the crust that covers the softened soil underneath. He thus created new conditions for the erosive forces which from now on could wash down the soft soil onto the wadi grounds. This process was originated only by active intervention of man.

To lay bare the soil and then allow it to be washed off unhampered into the canals which directed it onto the cultivated plots below, our ancient farmers had to rake together or pick up the stones that formed the *hamada* cover, and the logical thing to do was to heap them into mounds. The mounds, then, had an origin but not a function. They served no purpose in themselves in ancient agriculture, they were simply dumps of material to be cleared from the ground. They were the by-product of man's endeavour to create cultivable land where the probability of run-off would be highest when it rained somewhere in the area—to bring together soil and water, the two fundamental elements of agriculture, at the most favourable spot. This interpretation is borne out by the invariable correlation of fields of mounds above and cultivable plots below.

This study would not be complete without a short summary of what can be learned about the climate of the times from a survey of the remains of agriculture in this area. One way of finding out is to work out the ratio between the size of the cultivated fields and the area of the catchment that fed them with water; another, to determine the relation between the capacity of the cisterns and the area of the catchment whose run-off was channelled into them. Much can also be surmised from the general principles on which this ancient agriculture was based. All of these methods prove conclusively that the climate here was as arid then as it is today, and that from this point of view there is no difference between the central Negev

and the Egyptian regions with which G. W. Murray deals in his article. The required ratio of 1 to 12 between the size of any area where deep-rooted perennials can be grown and the extent of the catchment that provides it with run-off, for instance, is based on rainfall and surface flow measurements recently recorded by settlements in this climatic zone. It also happens, however, to be the ratio between every field cultivated by the ancient settlers of the Negev and the size of the catchment that supplied it with water. Where this ratio did not prevail under natural conditions, canals were built to establish it.

The conclusion that both rainfall and the rate of surface flow were much the same then as today is supported by the ratio between the capacity of each cistern in the area and the size of the catchment that fed it with run-off. It averages 1 cubic metre of cistern capacity to 30 square metres of catchment, because the builders were on the conservative side in their calculations in order to make sure that the cisterns would fill up in dry years as well. Finally, if all agriculture here was based on run-off, it must have rained on only a few days out of the season and the showers must have been heavy, resulting in immediate floods. Not only the annual precipitation but also its distribution and character, then, must have been the same as today.

Summary

The central Negev lies beyond the borders of the settled land of Israel. South of it is a desert region, which remained outside the domain of human habitation throughout all the periods of history; north of it are steppes and the Mediterranean lands which have always been inhabited. The central Negev, on the other hand, was settled at times and deserted at others, but at such times as it was inhabited, it was able to support its population, at least to a considerable extent.

It appears, then, that this region is not an absolute *anoecumene* but a "*pseudo-anoecumene*," which lacks neither of the elements essential for agriculture—soil and water. Almost nowhere, however, are soil and water available at the same place. Water, furthermore, is available for very short times only, at highly irregular intervals. When man knew how to bring water and soil together, the region became an *oecumene*. At other times it reverted to desert.

The physical features of the central Negev lead the geographer to expect a nomadic population, the absence of agriculture, and a low level of civilization—and this is just what he finds there today. What remains of the ancient settlers' fields and habitations, however, spells out the very opposite. With the dams and canals to which it owed its existence, there was created here agriculture of a very advanced type by growing crops on a series of absolutely level fields by inundation with flood water.

This, however, is another striking example to show that there is no fixed relationship between man and land and that, furthermore, there is no absolute land use classification, fixed by nature alone, applicable even to desert areas. Here, as in many other similar cases, it depends on man whether a certain stretch of arid land belongs in the category of the desert or the sown.

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THE EVOLUTION OF THE RELIEF OF THE CAM VALLEY

B. W. SPARKS

EAST ANGLIA and adjoining districts, with their wealth of glacial deposits and monotonous relief, have stimulated research into problems of drift geology, but the development of relief has been largely neglected. The valley of the river Cam is no exception, for the papers concerned with its drift geology make little or no mention of the problems of relief.

The Cam is one of the smaller rivers draining the region surrounding the Fens: it has three branches which, because of confusion of names, will be called the Ashwell, Saffron Walden and Linton branches, after the main settlements found in the valleys. The river system is short: from its farthest source near Elsenham to its junction with the Old West River near Stretham it is little more than 30 miles long. The area drained by this system falls into three natural divisions (Fig. 1).

To the south-east is a low Chalk plateau with a variable but usually considerable thickness of boulder clay. The plateau is bounded to the north-west by a gentle and irregular escarpment which, from its indented character and its broad, shallow coombs, appears to be of considerable age and to have suffered little erosion for a very long time. Nowhere does it approach in steepness the characteristic Chalk escarpments of the south of England. The crest of the escarpment is highest in the south-west, where it reaches 550 feet O.D. south of Royston. It falls in elevation north-eastwards to 380–400 feet O.D. near the Saffron Walden valley and retains that elevation as far as Newmarket. Even where it is highest it is not impressive, for an area of lower dissected plateau at about 300 feet O.D. lies in front of it. The general pattern of valleys on the plateau follows the slight dip to the south-east, but the Linton and Saffron Walden streams are exceptional in flowing against the dip. The latter is especially noteworthy, for it rises some 10 miles south of the Chalk escarpment and is an obsequent stream of unusual length for Chalk regions.

North of the plateau lies the broad strike vale of the Ashwell stream, a valley of unusual size in relation to the stream occupying it. If the zone of terraces on the southern side of the valley is included, it is slightly more than 6 miles wide near its source at Ashwell and retains this surprising width until it merges into the Fens north of Cambridge. The zone of terraces on the southern side of the valley is cut mainly into the Middle Chalk and the Lower Chalk above the Totternhoe Stone, while the lower, more modern valley is cut indifferently across the Chalk Marl and the Gault (Fig. 1). These two rocks are almost equally lacking in resistance to erosion and, from a geomorphological point of view, the important lithological break is not the base of the Chalk but the level of the Totternhoe Stone.

North-west of the Ashwell valley a low plateau extends between the Cam and the Ouse valleys. This western plateau is of monotonous relief, reaching 270 feet O.D. in the south centre and sloping gently down usually to 200 feet, but locally in the north to 160 feet O.D., above the break of slope to the adjacent valleys. The plateau is essentially a boulder clay feature, for solid rocks outcrop in very few places on its surface, although the Lower Greensand comes to the surface in the south-west near Sandy and the Chalk in the south-east near Barrington. The surface of the solid rocks, which include all those locally represented between the Oxford Clay and the Chalk, is much lower and more irregular than the surface of the drift forming the plateau. The plateau is dissected by the Bourn Brook, which flows eastwards into the Cam and separates the eastern part of the plateau into two main ridges, one extending to Madingley a few miles west of Cambridge and the other to Barrington.

The terraces of the Ashwell valley

The Ashwell valley, because of the remnants of terraces found in it, lends itself more to the discussion of the evolution of relief than do the boulder clay covered parts of the region. The higher terraces are purely erosional forms, as are many parts of the lower terraces, except near Cambridge, where they are mainly aggradation

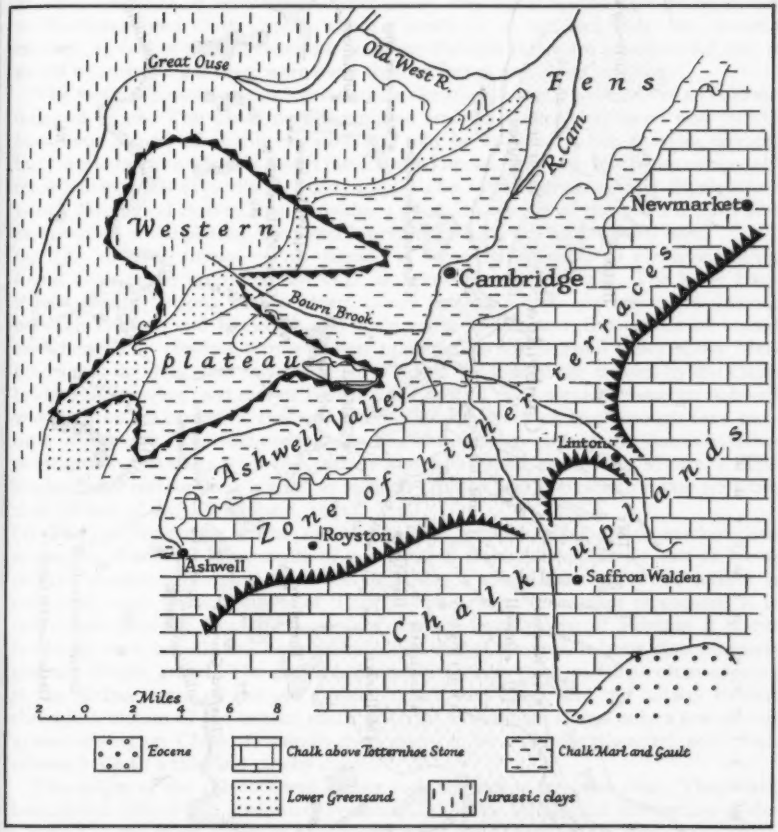

Fig. 1. Physical divisions and solid geology of the Cam valley

terraces. The sequence of the Cam valley terraces, which are mapped in Figure 2, appears to be the following:

(1) *The 330-foot terrace.*—The highest terrace, for which the evidence is least certain, occurs between 330 and 300 feet O.D. A number of dissected ridges and summits between Ashwell and Baldock and near Great Chesterford provide the only visible evidence. One spur near Great Chesterford is, however, more than a mile long and, although it is capped with boulder clay, this does not appear to be of any great thickness, especially if some allowance is made for downhill creep. In addition, the Chalk beneath the drift east of the Saffron Walden valley appears to have been planed off at about 330 feet O.D. This question will be dealt with more fully later

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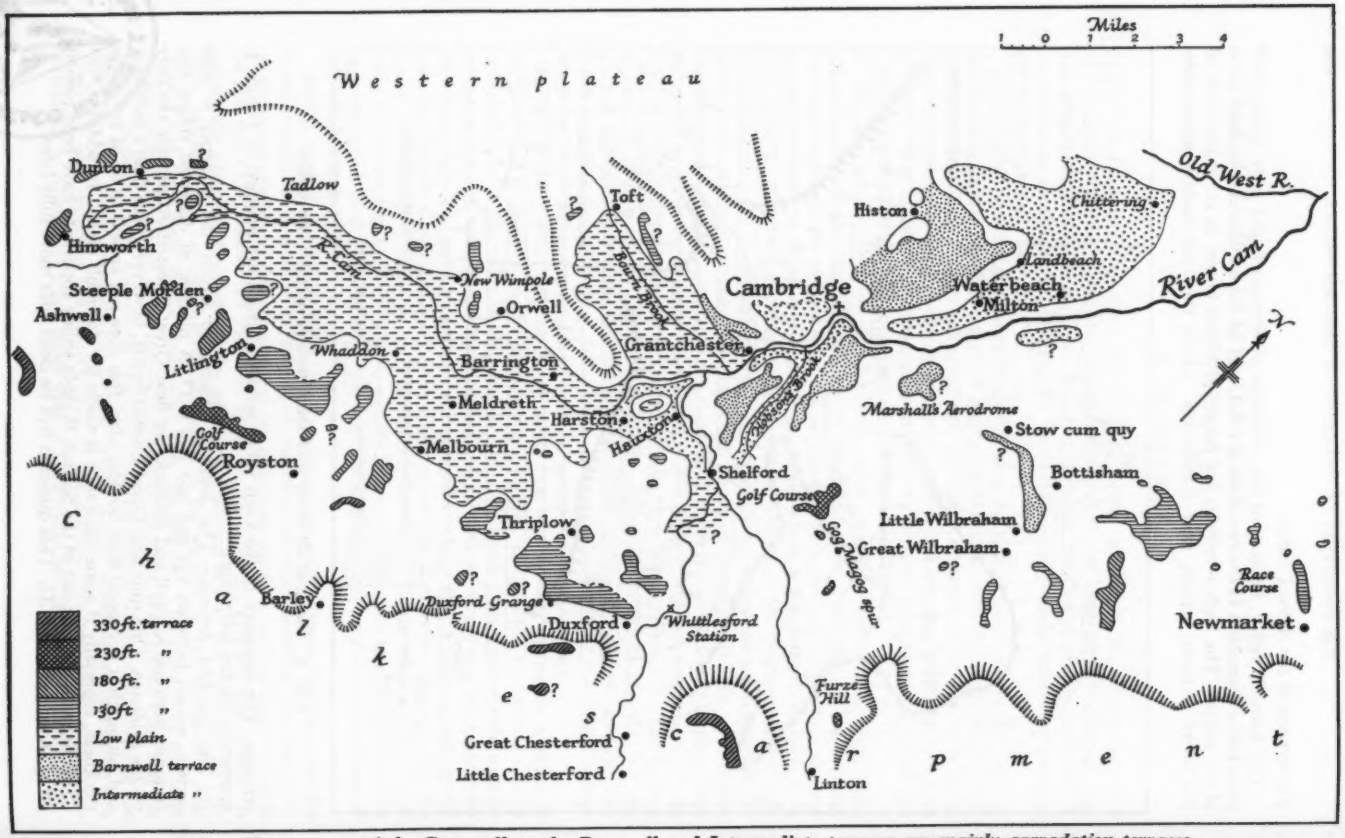

Fig. 9. The terraces of the Cam valley: the Barnwell and Intermediate terraces are mainly aggradation terraces.

(2) *The 230-foot terrace.*—The main evidence for planation at this level is a dissected shelf beneath the Chalk escarpment 2 miles west of Royston and the long undulating Gog Magog spur which projects north-westwards from the Chalk escarpment towards Cambridge. The broad rises on this spur generally reach a little above 200 feet O.D. and are usually capped with glacial gravel, which is probably of no great thickness. At Furze Hill gravel pit the underlying Chalk has been revealed at 215–210 feet O.D. A somewhat thicker gravel may occur on the golf course at the north-western end of this spur, where a small pit at 240 feet O.D. has recently exposed 12 feet of gravel. Attempts to auger through this were unsuccessful, but it would be surprising if there were more than 30 feet of gravel at this point.

The western plateau attains a comparable elevation, but it is probably of an entirely different origin. The Chalk near Barrington and the Lower Greensand near Sandy have been planed off at this elevation and may be included in the 230-foot terrace, but the plateau as a whole is a drift feature, thicknesses of 50–150 feet being commonly recorded in wells (Woodland, 1942, 1943). The section given on the Biggleswade 1-inch Geological Survey map provides a good illustration of the general form and composition of the plateau, the possible origin of which will be discussed later.

(3) *The 180-foot terrace.*—This terrace is somewhat variable in elevation, being found occasionally up to 190 feet O.D. and down to 160 feet O.D. The lower fragments possibly belong to a separate minor terrace, which appears to be distinct between Dunton and Eyeworth and again north of Royston, but cannot be traced elsewhere. The 180-foot terrace is best preserved in the Ashwell valley above Melbourn and the only clear fragment east of this is the level ridge crossed by the Cambridge–Newmarket road east of Bottisham. Some of the fragments between Ashwell and Royston are extensive, that east of Steeple Morden being large enough for a wartime aerodrome. The higher land forming the western end of the Ashwell valley conforms in elevation with this terrace and is mapped as such in Figure 2. The boulder clay resting on it is thin, as wells at Dunton and Hinxworth reveal no more than 16 feet of drift (Woodland, 1942).

(4) *The 130-foot terrace.*—The 130-foot terrace is much more clearly marked than any so far described. Fragments of it are found from Ashwell as far east as Newmarket, except in the vicinity of the Gog Magog spur. Even where the terrace is dissected, as in the area south of Thriplow and near Newmarket racecourse, it is readily recognizable from the accordant summit levels. West of Royston it is cut into solid rock, usually the Lower Chalk, but east of Royston it bears discontinuous spreads of taele gravel. The gravel is probably not very thick, as Chalk often appears at the surface, none of the old gravel pits are very deep, and the railway cutting through a section of the terrace south of Great Wilbraham shows only a few feet of gravel resting on Chalk. Generally there seems to be a slightly dissected, solid rock terrace beneath a thin and patchy gravel.

The origin of the 130-foot and higher rock terraces is far from clear. They have been noted before and attributed by some authors to lithological differences in the Chalk: "... the effect of certain hard bands in the Chalk, such as the Totternhoe Stone (or Burwell Rock) and the Melbourn Rock, can be distinguished by minor escarpments and dip slopes" (Darby (ed.), 1938, p. 1). A similar interpretation is conveyed by an illustration in Wells (1948, Fig. 93d), which shows minor scarps and dip slopes on both the Totternhoe Stone and the Melbourn Rock. A comparable idea, concerning the function of the Melbourn Rock as a ledge-former on the face of the South Downs escarpment, was investigated by Bull (1936), who came to the conclusion that the ledges were primarily fragments of erosion terraces. The same is probably true of the Cambridge region for the following reasons.

The slopes of the terraces are generally towards the river and not back towards the Chalk escarpment, as they would be if the harder bands of the Chalk formed minor scarps and dip slopes. Further, the section showing two terraces, one supported by the Melbourn Rock and the other by the Totternhoe Stone, is only true of a small

Fig. 2. The terraces of the Cam valley: the Boxmoor and Intermediate terraces are mainly aggradation terraces.

area near Royston (Fig. 3b). West of Royston the lower terrace is locally below the Totternhoe Stone, while the higher terrace appears to be held up by that bed, and the Melbourn Rock marks the base of the break of slope to higher ground (Fig. 3a). East of Royston the lower terrace is apparently supported by the Melbourn Rock, the Totternhoe Stone making virtually no impression in the low plain to the north (Fig. 3c). A critical area lies immediately west of Litlington, where the terrace level changes from the 130-foot to the 180-foot in less than a mile without there being any comparable rise in the level of the Totternhoe Stone apparently supporting it. Although the general relationship between hard bands and terraces suggests that the terraces are erosional forms independent of structure, there is, unfortunately, no example of one terrace fragment cut across either of the hard bands of the Chalk.

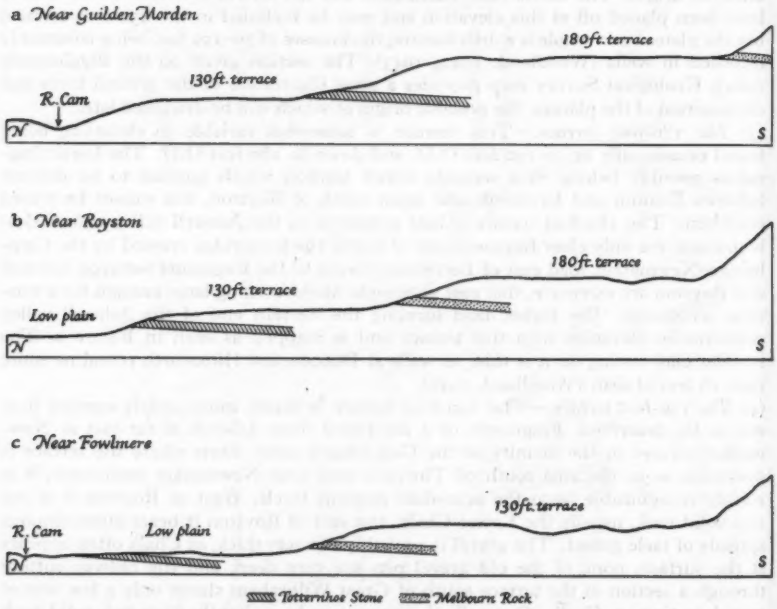

Fig. 3. Sketch sections to show relations between terraces and Totternhoe Stone and Melbourn Rock

Whether this is the real state of affairs or whether the hard bands, in the absence of exposures, have been mapped along the fronts of the terraces, is not certain. The subsequent recession of the fronts of the terraces has probably been controlled by the spring lines at the levels of the Totternhoe Stone and Melbourn Rock, thus accentuating the apparent relationship between hard bands and terraces.

The horizontality of the 130-foot terrace is a surprising feature. It excludes the interpretation of the terrace as a former valley floor of the river Cam, as that sluggish river falls today from above 100 feet O.D. near Ashwell to about 15 feet near Cambridge. Either a lake or the sea could provide the mechanism necessary for the formation of a horizontal terrace, but there is no geological evidence for either at this level. It is true that marine gravels occur in various places in the north of the Fens (Marr, 1926; Marr and King, 1928; Baden-Powell, 1934), but these are at a lower level and represent a more limited marine invasion at a later date. They do,

however, indicate the possibility of former marine invasions of the Fens through the Wash.

Further afield, the 130-foot terrace is found at a constant elevation around the

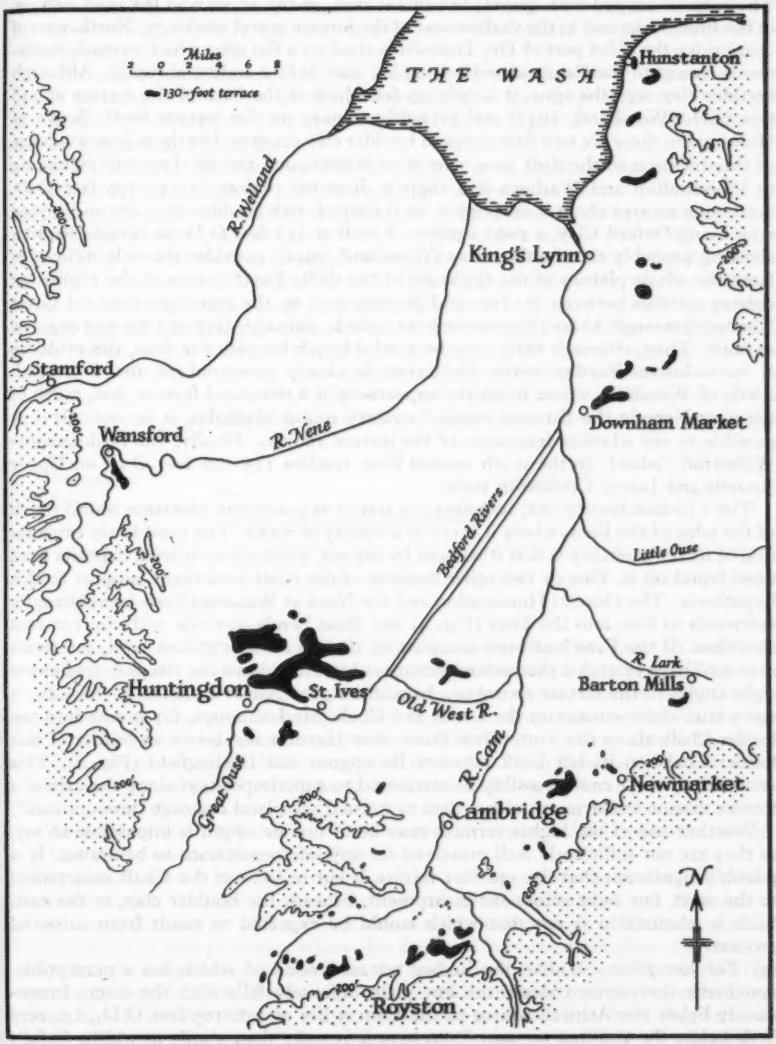

Fig. 4. The 130-foot terrace round the Fens

margin of the Fens, but seems to be absent from the north-west (Fig. 4). The low plateau occupied by the higher part of Hunstanton and the terrace north-east of Heacham are cut into the Chalk at this level, while the Lower Greensand spur at Sandringham provides a first-class example of the terrace. East of Kings Lynn and

Downham Market various fragments of terrace are found: most of them appear to be solid terraces, occasionally with a thin veneer of drift. South of Downham Market the next evidence is provided by a flat-topped ridge 2 miles south of Barton Mills. The ridge is capped with gravel; but this is thin, as can be seen in the road cutting, in the lime works and in the shallowness of the former gravel workings. North-west of Cambridge the older part of Dry Drayton is sited on a flat spur which extends northwards almost to the Cambridge–Huntingdon road before ending abruptly. Although boulder clay caps the spur, it is only 25 feet thick at the back of the terrace at 148 feet O.D. (Woodland, 1942) and probably thinner on the terrace itself. South of Huntingdon there are two flattenings in boulder clay country, but there is no evidence of the thickness of the drift here. North of Huntingdon and St. Ives and extending to Woodwalton and Warboys is a slightly dissected plateau at 130–100 feet O.D. occupying an area about 7 miles by 6. It is capped with boulder clay, the underlying rock being Oxford Clay, a poor aquifer. A well at 118 feet O.D. at Abbots Ripton, showing probably thin boulder clay (Woodland, 1942), provides the only indication from the whole plateau of the thickness of the drift. Exact details of the significant railway cuttings between St. Ives and Ramsey and on the main line (the old Great Northern) through Abbots Ripton are not available, although Oxford Clay was exposed in both. Thus, although there may be a solid bench beneath the drift, the evidence is inconclusive. Further north, the terrace is clearly preserved on the Cornbrash south of Wansford, where it has the appearance of a structural feature, but, north of the river Nene in the flat and wooded country round Marholm, it is virtually impossible to say whether fragments of the terrace remain. Finally, the Haddenham–Wilburton "island" in the south central Fens reaches 115–120 feet O.D. on Upper Jurassic and Lower Cretaceous rocks.

The 130-foot terrace can, therefore, be traced at a constant elevation round much of the edge of the Fens, where it is cut in a variety of rocks. The most likely explanation of its horizontality is that it was cut by the sea, although no marine deposits have been found on it. One or two other features of the relief lend slight support to this hypothesis. The Ouse at Huntingdon and the Nene at Wansford both bend abruptly eastwards to flow into the Fens (Fig. 4) and these bends coincide with the 130-foot shoreline. If the Fens had been occupied by the sea at the 130-foot level, the rivers may well have extended themselves, when sea level fell, down the steepest gradient at right angles to the former shoreline. In addition, the Ashwell branch of the Cam is not a true strike stream on the Gault and Chalk Marl outcrops, for it cuts into the harder Chalk above the Totternhoe Stone near Harston and leaves an outlier of this harder Chalk on its left bank between Barrington and Haslingfield (Fig. 1). This anomalous course could possibly be attributed to superimposition along the axis of a former marine embayment, rather than to normal scarpland drainage development.

Whether any of the higher terraces may be of marine origin is impossible to say, as they are not sufficiently well preserved for any safe conclusions to be drawn. It is possibly significant that the 330-foot terrace is cut in front of the Chalk escarpment to the west, but right across the escarpment, beneath the boulder clay, in the east. Such a relationship is not that which would be expected to result from subaerial erosion.

(5) *The low plain.*—Unlike the higher terraces, none of which has a perceptible, systematic downstream slope, the low plain definitely falls with the river. Immediately below the Ashwell source of the Cam it lies at 110–105 feet O.D., *i.e.* very little below the 130-foot terrace. Even here it is more than a mile in width. It falls downstream to 90–65 feet O.D. north of Royston, where it is 3 miles wide, narrows to 1 mile near Harston, and again expands in width towards Cambridge, where it lies at 80–50 feet O.D.

In the upper part of the valley it is a simple broad terrace into which the present stream is slightly incised. Between Wimpole and Barrington the north bank of the river is marked by a comparatively sudden rise of 10–15 feet, while the land rises

gently and steadily away from the river to the south. It seems that the stream is here cutting into, and northwards across, its valley, although the presence of bluffs at Whaddon and south-west of Meldreth appears to indicate an earlier tendency to cut southwards (Fig. 5). Although the stream has been slightly rejuvenated since the formation of the low plain, it does not appear possible to make a satisfactory separation of terraces.

Downstream from Harston the low plain apparently divides into the series of gravel terraces, well-known in the Pleistocene geology of the region. There are probably three terraces, only the upper two of which are significant geomorphologically and are mapped in Figure 2.

The Barnwell or High terrace.—The terrace appears at about 65 feet O.D. between Shelford and Trumpington, runs through the south-east and east of Cambridge, is broken by the west–east reach of the Cam north of the gasworks, and continues north of the river at approximately 48–40 feet O.D. It ends a mile north of Histon at a relatively marked break of slope and immediately west of Landbeach, where the break of slope is perceptible though less marked. The terrace is a gravel feature throughout. It has yielded a distinctive mollusc fauna, while parts of it have recently been dated as Last Interglacial in age by botanical methods (Hollingworth, Allison and Godwin, 1950; Walker, 1953). From its elevation it appears to be the downstream continuation of the low plain, although the one is depositional and the other erosional.

It is often difficult to decide whether one is dealing with the low plain or the Barnwell terrace, especially east and west of Cambridge. At the northern foot of the

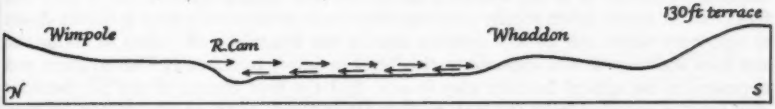

Fig. 5. Sketch section of low plain north of Royston. Arrows indicate probable lateral shifting of River Cam

western plateau and between the Chalk escarpment and the Fens east of Cambridge are broad areas of low ground, which appear in places to slope very gently down into the Fens and in others to consist of minor terrace fragments, some of which have a gravel capping. The most definite terrace fragments are to the east of Cambridge near Marshall's aerodrome and between Little Wilbraham and Stow cum Quy, where a long fragment of terrace falls from 75 to 55 feet O.D. in 2 miles. This particular terrace has a cap of gravel, which has not been observed to exceed 9 feet in thickness (Penning and Jukes Browne, 1881), but it is impossible to say whether it is part of the Barnwell terrace in the absence of sufficient palaeontological information, although it is tentatively mapped as such in Figure 2.

The Newnham or Intermediate terrace.—This terrace usually lies 20 feet below the Barnwell terrace. It appears near Harston and between Shelford and Hauxton at 50–40 feet O.D., and its thin gravel is extensively worked south of Hauxton church. It disappears at Grantchester, where the Barnwell terrace approaches the river on either side, but expands to the north on the west side of Cambridge. East of the river it probably extends along Trumpington Road and over much of the centre of Cambridge, but it is very difficult, if not impossible, to separate it from the Barnwell terrace there. In Cambridge it lies approximately at 40–30 feet O.D. Northwards it follows the river as a narrow strip, but expands rapidly to 1 mile in width between Milton and Waterbeach, where it is at 20–16 feet O.D., and even more to the north, where it falls to 12–10 feet O.D. before finally disappearing into the Fens north of Chittering.

The Barnwell Station or Low terrace.—This terrace is merely the narrow modern floodplain of the river and is not mapped in Figure 2. It can be seen in such places

as the Backs at Cambridge and near Waterbeach station. Below the modern alluvium are late Pleistocene gravels filling a slight buried channel. These yielded a cold flora and fauna at Barnwell Station (Marr and Gardiner, 1916; Marr, 1920).

The development of relief in relation to glaciation

The discussion of the relation of relief development and glaciation would be much easier if there were general agreement on the Pleistocene succession of the district. Unfortunately, the relations between the boulder clay on the plateaus and the gravels in the valleys are obscure, so that the Pleistocene succession is largely a matter of opinion. The only terraces dated with reasonable accuracy are the Barnwell terrace, the gravels of which were deposited in the middle and later parts of the Last Interglacial; and the Barnwell Station terrace, the gravels of which date from the time of the Last Glaciation. The boulder clay is earlier than both of these features, but whether there is more than one boulder clay is uncertain. The only positive evidence is the difference in stone orientation, established by West and Donner (1956), which leads them to suggest that the western plateau drift is Lowestoft (Elster) in age and the drift on the Chalk uplands to the south is Gipping (Saale). If these two local boulder clays really belong to different glaciations and not to different phases of the same glaciation, the following treatment in terms of pre- and post-boulder clay relief evolution involves a certain lack of precision.

The relief before the deposition of the boulder clays.—For this part of the discussion it is convenient to consider the three main regions defined earlier in this paper. Although the boulder clay cover of the western plateau does not usually descend below 200–150 feet O.D., it comes down locally to lower elevations: in the north-west it occurs down to and even below the 50-foot contour and in the Bourn Brook valley to about the 100-foot contour. It was exposed at this level in sewer trenches at Toft in 1952 and appeared to be typical boulder clay *in situ*. But the true nature of the pre-boulder clay relief is revealed from the well records (Woodland, 1942, 1943). As can be seen from Figure 6, the western plateau, before the deposition of the boulder clay, was an area of undulating relief ranging from above 200 feet to below 50 feet O.D. There are insufficient well records to reconstruct the detailed relief with certainty, but the Bourn Brook appears to have had two strike tributaries along the Gault outcrop. The small depression enclosed by the 50-foot contour over the Lower Greensand inlier may be due to glacial scouring or, possibly, to misinterpretation of the rocks in the wells: if a certain thickness of Gault was mistaken for boulder clay, the surface of the solid rocks would appear to be lower than it really is. This does not seem very likely, as the depression is based on three well records.

The broad valley of the Ashwell stream presents a more difficult problem, as there is little boulder clay within the valley. Boulder clay is mapped at about 125 feet O.D. at Dunton Lodge, 2 miles north of Ashwell, and material resembling weathered, sandy boulder clay was exposed at about 115 feet O.D. a mile north of Dunton Lodge when a field was supplied with water in 1953. Boulder clay is also recorded in wells at 90–100 feet O.D. at Orwell and Tadlow (Woodland, 1942). The remainder of the evidence that the valley is pre-boulder clay is indirect. At Barrington it seems that a pre-boulder clay solifluction flowed down a slope almost identical with that of the present valley side and spread out at an elevation little above that of the present valley floor (Sparks, 1952). Five or six miles away on the other side of the valley the taele gravels, which were probably deposited by solifluction down the Chalk escarpment immediately after the glaciation, lie on the higher terraces within the valley near the foot of the Chalk escarpment. The whole question must be considered in a wider context. Both the western plateau and the Chalk uplands to the south were dissected at least to their present depth before the boulder clay was deposited, while the Fens are also largely underlain by boulder clay (Skertchly, 1877). The whole drainage system must have been related to a common base-level and it is inconceivable that the tributaries of the Ashwell stream were in existence before the trunk valley itself was

cut. Indeed, from its breadth and the presence of high terraces in it, the Ashwell valley appears to be the oldest valley in the area. These points support the conclusion of Penning and Jukes-Browne (1881, p. 78) that "the Cambridge valley, as such, is

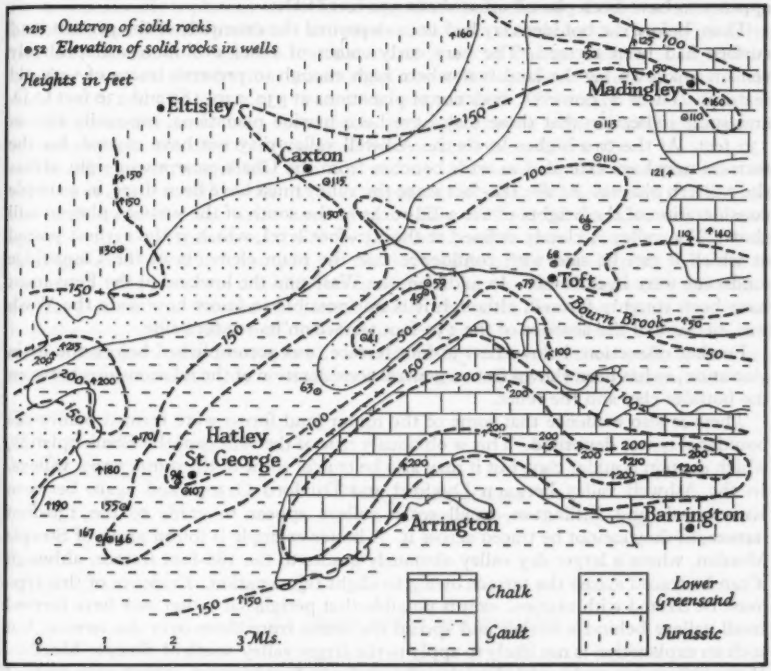

Fig. 6. Generalised sub-boulder clay contours on the western plateau

Pre-glacial or at all events . . . existed very much in its present form before the boulder clay was deposited."

On the Chalk uplands to the south, boulder clay is widespread. Sections recently visible at Little Chesterford (Sparks, 1955), Wicken Bonhunt and in the valley of the

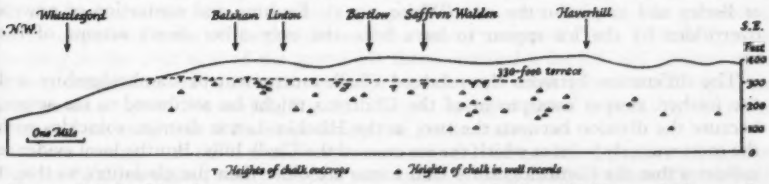

Fig. 7. Sub-boulder clay surface of escarpment between Saffron Walden and Newmarket

Debden Water have shown boulder clay down to or almost to the bottoms of the present valleys. Thus, the valleys are largely pre-boulder clay features, and so is the Chalk escarpment, which is flanked to the north by pre-boulder clay terraces. But the monotonous 380–400-foot plateau east of the Saffron Walden valley is not a true reflection of the pre-boulder clay relief, as may be appreciated from the well records (Woodland, 1942, 1943). Figure 7, which is a composite profile, shows the height of

the surface of the Chalk in wells and outcrops projected on to the section. It can be seen that the Chalk outcrops at about 330 feet O.D. on the present escarpment, but, unlike the present surface, does not rise to the south-east. Indeed, the Chalk appears to have been planed off at about 330 feet O.D.

Thus, before the boulder clay had been deposited the essentials of the present land surface had been formed. The very early stages of relief evolution will probably remain unknown for the land is nowhere high enough to preserve traces of very old features. There is, however, evidence of planations at 330, 230, 180 and 130 feet O.D. and some indication that these may have been marine planations, especially that at 130 feet. At the two higher levels the Ashwell valley may not have existed, for the terraces may have extended as wide benches from the Chalk escarpment right across the western plateau. At the 180-foot stage the valley must have been there, as a simple consideration of the heights of the solid rocks in the south of the western plateau will show. The valley is clearly defined at the 130-foot level, which is the earliest period at which it can be said with confidence that the main elements of the Cambridge landscape were in existence. In addition, the Wash and the lowland of the Fens must have been roughly formed, although it is not possible to know how wide the Wash was, because of the absence of the 130-foot terrace on its western side.

Further dissection, below the 130-foot terrace, was accomplished before the main glaciation, as has been shown from a general consideration of the relationships between the boulder clay and the relief.

There is also evidence that some of the minor land forms were formed before the boulder clay was deposited. This is obviously true of the valleys of the Chalk uplands, which contain boulder clay, but it may also be true of some of the minor scarp valleys. In the Ashwell valley between Duxford and Duxford Grange and again between Kneesworth and Litlington, small scarp valleys appear to grade to the 130-foot terrace, as they cannot be traced across it. A better example is found south of Steeple Morden, where a larger dry valley obviously grades to the 180-foot terrace, although it can be traced across the terrace owing to slight rejuvenation. Evidence of this type must be treated with caution, as it is possible that periglacial action may have formed small valleys behind a terrace and spread the waste from them over the terrace, but such an explanation is not likely to apply to the larger valley south of Steeple Morden. If the valleys are truly graded to the 180- and 130-foot terraces, which were formed before the main glaciation, they must be very old features of the landscape.

Modifications of relief caused by the main glaciation.—Signs of erosive action directly due to the ice are very few. Near Ely, a little to the north of the district described, is the famous Roslyn Hole erratic, a mass of Chalk, Gault and Lower Greensand, 50 yards in maximum width and over 400 yards long (Skertchly, 1877). Local disturbances and shearing of the Chalk at the crest of the escarpment have been described at Barley and in pits to the east (White, 1932). Faulting and contortion of gravels overridden by the ice appear to have been the only other direct actions of the ice.

The differences between the subdued Chalk escarpment of Cambridgeshire and the fresher, steeper escarpment of the Chilterns might be attributed to ice action, because the division between the two, in the Hitchin–Luton district, coincides with the most westerly point at which the ice crossed the Chalk hills. But the local evidence indicates that the Cambridgeshire land forms are older than the glaciation, so that it appears better to attribute their subdued nature to protection beneath the ice rather than to heavy glacial erosion.

The effects of glacial deposition are much more marked. Because the landscape before the glaciation was at least as deeply dissected as it is now and because an average of more than 50 feet of boulder clay has been plastered on to the uplands, the range of elevation of the area has been increased by the ice sheet. At the same time, there has been a certain amount of valley filling, especially in the western plateau. Thus, although the range of elevation has been increased, the relief has been simplified

by the formation of boulder clay plateaus less diversified in relief than the surfaces of the solid rocks beneath them.

The deposition of boulder clay on the Chalk uplands is understandable, because there was already a plateau to act as a base, but the building of the western plateau presents more difficult problems, as a plateau has been created by the deposition of the boulder clay there. It may be that the lower layers of the ice, heavily charged with debris, were retarded by the remnants of the solid 230-foot terrace at Sandy and Barrington and the material released by bottom melt. This may have led to the formation of a smooth form over which the ice later rode without hindrance, but it is impossible to see why this happened here and not everywhere else.

The alternative suggestion, that the western plateau is an erosion form, involves even more serious difficulties. If it is erosional, it must be later than the boulder clay and either the sea must have risen rapidly and planed the area off, or river aggradation, in response to a rise in base-level, must have brought all the local drainage up to above 250 feet O.D., so that it could form the western plateau by lateral erosion. In the first case it is difficult to see why the sea should have effected such a perfect planation of the western plateau and left no mark elsewhere, while the second hypothesis would require millions of tons of aggradation gravels in the valleys and their subsequent complete removal without trace. Both seem more unlikely than the idea that the plateau is due to some little-understood form of glacial deposition.

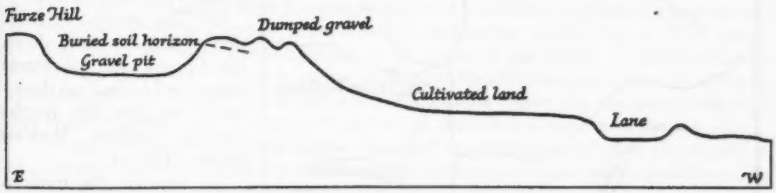

Fig. 8. Sketch section at Furze Hill

Other small depositional forms may be associated with the decline of the glaciation. It has been said (in White, 1932) that ice-contact slopes are preserved on some of the patches of gravel on the Gog Magog ridge facing the Linton valley, especially at Furze Hill. It seems very doubtful whether the western slope of Furze Hill is an ice-contact slope. Long-continued cultivation of the more fertile ground below the gravel patch has probably led to the creep of soil downhill away from Furze Hill: the occurrence of such a movement may be demonstrated by studying the relative level of the land on either side of the lane, 100 yards to the west. But there is probably a more important cause of the steepness of the western slope of Furze Hill: in 1950, a cutting in the west side of the gravel pit there revealed a buried soil horizon with gravel dumped above it, and, two or three years later, further gravel was dumped on the western side of Furze Hill (Fig. 8). This dumping of gravel is probably the main cause of the steepness of the slope facing the Linton valley.

More certain but far less striking constructional forms may be observed in the Saffron Walden valley, where the first two subdued spurs south of Great Chesterford station appear to be degraded waste fans derived from the higher ground to the west. The northern one was exposed in the railway cutting, where McKenny Hughes (1916) proved 22 feet of gravel without meeting Chalk. The southern one was recently cut across in the Bordeaux Pit, where no Chalk was exposed, while borings west of the pit on the other side of the railway proved 22 feet of gravel without reaching Chalk (Sparks, 1955). A similar subdued form may be present on the west side of the Linton valley a mile north of that village, because an old pit near Little Linton shows rubbly gravel of Chesterford type in the end of a very subdued spur. There may be

more features of this type, but they cannot be detected with certainty unless gravel pits happen to be opened in favourable localities.

Diversions of drainage associated with the glaciation.—In spite of its unusual width it is likely that the Ashwell stream has always occupied its present course. The possibility that the valley may be a former course of the Great Ouse may be dismissed, for, if that had been so, the Great Ouse valley below the point of presumed capture should show some signs of youth, whereas in fact its valley is as broad and old-looking as the Ashwell valley.

The only area where glaciation appears to have interfered with the drainage and where reversal has previously been suggested (Irving, 1898; Marr, 1926) is in the Saffron Walden valley, which possesses a number of unusual features.

(*a*) It is an obsequent stream unusually long for Chalk scarplands.

(*b*) The terraces of the Ashwell valley seem to be absent from this valley.

(*c*) The general orientation of tributaries is down the dip towards the Stort: many double back on themselves to join the north-flowing Saffron Walden stream (Fig. 9).

(*d*) Beneath the modern north-sloping valley is the deep buried channel, which slopes generally southwards.

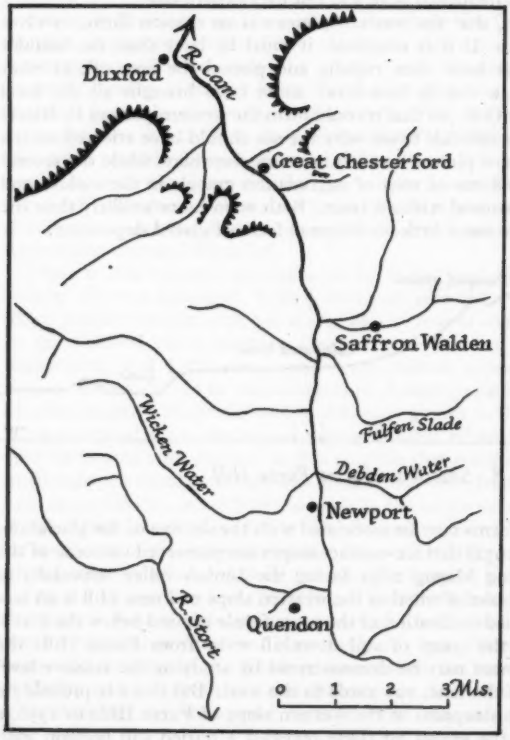

Fig. 9. Tributary pattern of the Saffron Walden stream

The general orientation of the tributaries and the lack of typical Cam terraces suggests that the valley was originally in the upper part of the Stort system and has been reversed at a comparatively late date. The most likely cause would appear to be glacial diversion and the following tentative sequence of events may have happened.

A lake, ponded between the advancing ice sheet and the Chalk escarpment, may have overflowed through a notch in the escarpment into the upper Stort valley and quickly cut down into the Chalk. A little later, when the ice sheet covered the area, the overflow valley was occupied by a powerful subglacial stream which ripped out the deep channel. This channel is unlikely to have been formed by a normal river for several reasons. It is very narrow and steep-sided, the side slopes reaching 45–50 degrees, *i.e.* approximately 15 degrees steeper than the steepest of present Chalk slopes. Its base is at least −100 feet O.D., while the comparable buried channel in the upper Stour valley reaches −347 feet O.D. at Glemsford: these depths are far too low to be explained by a low glacial sea level, especially when the probably distant position

of the shoreline at that time is considered. Finally, the channel appears to rise towards Bishop's Stortford, where a close scatter of wells makes it unlikely that the deepest part of the channel has been missed: this reversal of the slope of the long profile cannot be explained if it is held to be a normal subaerial valley. The generally southward drainage at approximately the time of the main glaciation can be inferred from the fact that puddingstones and typical Tertiary flint pebbles do not seem to occur in the gravels more than a few miles north of the present Tertiary outcrop. After the ice melted, the valley was probably choked with drift and with waste fans of the type seen at Little Chesterford. On this irregular surface the present Saffron Walden stream is thought to have picked its way northwards. An alternative explanation, which involves passing the Thames northwards from London to Cambridge (Sherlock, 1924), appears very unlikely both from the local evidence and from the work which Wooldridge and Henderson (1955) have done on possible earlier courses of the Thames through Essex and Suffolk.

Land forms in the Last Interglacial period.—In the last stages of the melting of the ice sheet, there must have been large quantities of meltwater, which largely scoured the main valleys free from any boulder clay and other glacial deposits occupying them. Much of the clearing of the upper part of the Ashwell valley, which is virtually free from drift, may date from this period.

During the Last Interglacial, the Ashwell stream seems to have been cutting into the low plain in its upper reaches and forming aggradation terraces lower down its valley. It was least active near Harston, where the valley is comparatively narrow and where outliers of the 130-foot terrace extend well to the north (Fig. 2). The reason for this lies in the relation of the stream to the strike of the Chalk. As far as Harston the stream flows very obliquely down the dip, so that at Harston it met the greatest thickness of the resistant Chalk above the Totternhoe Stone, the removal of which it has not completed. Hence the width of the low plain is at a minimum here.

The aggradation responsible for the Barnwell terrace continued after the middle of the Interglacial, as is shown by cold mammals in the upper parts of the gravels and by recent botanical work (Walker, 1953). The increasing cold should have been accompanied by a fall in base-level and by a rejuvenation of the river, which obviously did not occur immediately. A fall in level in the North Sea involves an outward migration of the shoreline over a sea floor little if any steeper than the profiles of the rivers draining into it. Any slight rejuvenation may well have been temporarily masked by aggradation upstream resulting from an increase in the ratio of load to discharge.

The effect of the rejuvenation was, however, felt later and resulted in the Cam falling from the level of the Barnwell terrace to that of the Intermediate terrace. The gravels of this terrace exposed at Hauxton and recently exposed in the foundations of the new buildings of Clare College appear to be unfossiliferous, while the mollusca from old sites in the terrace present conflicting evidence as to the climate, although a fauna colder than that of the Barnwell terrace and more like that of the Barnwell Station terrace below was found in the upper level of the Downing Site section (Kennard and Woodward in Marr, 1920). A second rejuvenation led to the formation of the Barnwell Station gravels, which underlie the lowest terrace. These have a cold fauna and correspond in age to the Last Glaciation, which did not reach the district.

Geomorphological changes associated with these events were small. Downstream from Cambridge, the river appears to have shifted eastwards, as the Barnwell terrace continues more directly north than the present river (Fig. 2). Upstream some alterations occurred near Great Shelford (Fig. 2), where either the Saffron Walden stream or the Linton stream or both originally flowed along the valley of Hobson's Brook. Osborne White (1932) took the view that this was the course of the Linton stream, which was captured by lateral shifting of the Saffron Walden stream at the level of the Intermediate terrace. Any other explanation creates difficulties, because the width of the Intermediate terrace along the Saffron Walden stream at Hauxton suggests that this course is old. The cutting of the Ashwell stream into its own low plain above

Harston may well be associated with the rejuvenations responsible for the Intermediate and Barnwell Station terraces near Cambridge. The Saffron Walden stream seems to have been inactive in its upper reaches. True Interglacial deposits of the Barnwell terrace are not known above Trumpington; upstream the river appears to have been incapable of moving the gravels in its valley. It may be that the formation of the Barnwell terrace round Cambridge corresponds merely to a period of surface weathering of the gravels in the upper parts of the Saffron Walden valley.

No land forms definitely associated with the Barnwell Station cold phase have been recognized, although the fresh-looking little valleys on Royston golf course may date from this period. The Post-glacial amelioration of climate and rise of base-level, although responsible for the Fen peats and silts, have had little effect in this area apart from the accumulation of black mud along the river near Cambridge, the deposition of silty alluvium derived from the boulder clay in the upper parts of some valleys, and the downhill creep of material on the hillsides. The creep has probably been accentuated by man's interference as appears to have happened at Barrington (Sparks, 1952).

If this analysis is correct, the major elements of the relief are old and were in existence long before the main glaciation of the district, since the ice appears to have advanced into a district of which the landscape was very much like that of the present day. To this older period belong the terraces of the Ashwell valley, from the 330-foot down to the 130-foot. The ice sheet itself seems to have left its imprint mainly in the monotonous boulder clay plateaus, and possibly in the initiation of the north-flowing Saffron Walden stream. After the glaciation, geomorphological changes were small and confined mainly to the floors of the valleys.

The question of geologically recent warping is always of interest to students of the relief of areas adjacent to East Anglia. None of the Cam terraces has suffered recognizable warping: the only feature which might be construed in that way is the general eastward fall in the level of the Chalk escarpment, but there are other possible explanations of this.

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DISCUSSION

Afternoon Meeting, 26 November 1956

Before the paper, the CHAIRMAN (Professor L. DUDLEY STAMP) said: This afternoon we are to have the privilege and pleasure of a paper entitled "The evolution of the relief of the Cam valley." Our lecturer is Mr. B. W. Sparks, university lecturer in geography in Cambridge.

Mr. Sparks then read his paper

The CHAIRMAN: I am anxious that there should be a frank exchange of views this afternoon, and I do not want to formulate the discussion, but there are some I know we should like to hear from. I call first upon Professor Wooldridge.

Professor S. W. WOOLDRIDGE: I have listened to this paper with the keenest interest, firstly because prior to this very little had been done in the area south of Cambridge. My second interest is that I have been, and that quite recently, concerned myself with this area in the south. The single most important and challenging, though undoubtedly disputable, conclusion which Mr. Sparks has indicated this afternoon is his 130-foot terrace, which, on fairly good general grounds, he has hazarded to guess might be marine. May I venture to point out that things have got to be judged, which he himself said at one stage, in a wider context? You cannot work them out by concentrating entirely on the local evidence. Is there any reason to expect a marine terrace there? There is every reason to expect it, as there is world-wide evidence for it. I am anxious to know what date could plausibly be ascribed to that feature, because the evidence to which I refer would put it in the Great Interglacial Period; that is to say, it would be later than at least one of the two boulder clays to which he made reference. As far as I could gather, Mr. Sparks wishes to make all his terraces earlier than the glaciation of the district, but I wonder whether he can see any chance of relating that particular feature to either or any of the boulder clays?

I was a bit perturbed to see that Mr. Sparks' 130-foot terrace extended east of what I should call the Braintree line. If you run a line north–south from the mouth of the Thames near Gravesend through Braintree and continue it northwards, you have got the inner edge, the main line of warping, which fixes the western limit (as I conclude) of the North Sea depression. East of that I do not expect to find any of these levels at their expected heights and I am concerned, though we must go where the facts lead us, to find this evidence so widely spread along the eastern margin of the Fens. As Mr. Sparks hinted, there is every reason to regard the Wash as a probable site of a marine embayment, which must surely have functioned as such during the earlier interglacial periods, as it did in some of the later ones. If I had to hazard a pure guess as to a place north of the Thames where one might have looked for a feature (which is perfectly well marked on the south coast of England in the Goodwood raised beach of West Sussex) I would have said the western, not the eastern, part of the area which Mr. Sparks has surveyed tonight.

There are many points of detail that I should like to follow up more personally, but I think I've made the chief points that passed through my mind both before I heard the paper and while I sat listening to it.

Mr. K. M. CLAYTON (London School of Economics): I have listened with interest to this paper, for to me any piece of country that has glacial drifts on it immediately assumes some interest. This is not a usual point of view and I am glad to see that Mr. Sparks is with me in this. He referred at one point to the western plateau, I am not sure that he used the word "dull," but he certainly implied it. For myself I see a considerable interest in this very dullness. It is a flat surface of boulder clay; there are great slabs of boulder clay like this in East Anglia and a very large part of the east Midlands, occupying each of the interfluves between the major rivers. These slabs of boulder clay usually have a very characteristic, unintegrated drainage pattern. Now Mr. Sparks suggested, if I understood him correctly, that the boulder clay was lodged on the western plateau and on the summit of the Chalk cuesta in this area. I take it that he feels the Ashwell branch of the Cam never had much of a boulder clay cover. It seems to be difficult to explain non-deposition of the boulder clay in that particular 6-mile belt. It seems more reasonable to assume that it was once deposited and has since been removed. With reference to the large map showing the 130-foot bench around the Fens, I would question the inclusion of the area north of Huntingdon and St. Ives which seems to be thickly spread with boulder clay. I would suggest, however, that the surface occurs underneath the boulder clay on the western edge of the Fens between Huntingdon and Peterborough where the boulder clay often descends to about 130 feet and no lower. This would suggest that the surface is older than the overlying boulder clay. There is one other point I would like to take up, and that is the size of the valley of the Ashwell branch of the Cam. I find it necessary to evoke some agency other than this small stream either to strip the boulder clay from this area, or, if the boulder clay was not deposited, to form the wide valley seen today. Possibly the Ouse flowed through there in Pre-glacial times, or was diverted to this course by ice to the north.

Dr. ERIC H. BROWN (University College, London): I would like to add my congratulations to Mr. Sparks. I am intrigued by the levels at which the erosion surface remnants are found, particularly that at 330 feet, evidence for which has been growing in this country over the past few years. In some earlier work Mr. Sparks made use of a technique which we now call the "height-range diagram." If the remnants of the surfaces in the Cam valley were plotted in this way the presence or absence of tilting might be demonstrable.

Dr. G. H. DURY (Birkbeck College): Reference has been made to an erosion-platform in the east Midlands. The flat sloping surface on the backslope of Lincoln Edge is probably to be correlated with similar features which run through the Northampton Uplands and into the Cotswolds, and which although they are clearly erosional and obviously platforms are by no means horizontal. This however is largely by the way. The bench identified by Mr. Sparks at about 130 feet O.D. is far wider than the surviving part of the shore-platform of Glacier Lake Harrison in the Avon valley, and would seem to demand a long stillstand if it is to be interpreted as a marine feature. The Saffron Walden valley described by him is similar in several respects to the Hiz-Ivel valley, which also drains northward and which goes very deep in places beneath its fill of drift. It seems difficult to account for the deep excavation by any hypothesis of pre-glacial lakes.

Mention of large streams in former times directs attention to the fact that all streams in the area are misfit—the four main heads of the Cam, the Nene, the Great Ouse and the other rivers which drain towards the Wash are manifestly misfit. The hypothesis of high discharge both from surface run-off and from springs might go far to account for the forms of the side-slopes of the Ashwell valley. This particular problem, however, does not appear serious—there is a valley there and it has obviously been excavated by erosion. Little is to be gained by free postulations of stream courses

different from those of today, for in many parts of adjacent districts it can be shown that the present stream pattern is an antique one. There is on the other hand abundant evidence of more severe fluvial erosion in former times than at the present day.

Mr. S. C. A. HOLMES (Geological Survey): The physiographic study of the evolution of the Cam valley which Mr. Sparks has presented is of particular interest to geologists such as Professor J. H. Taylor and myself who have been concerned in the mapping of the Geological Survey's Cambridge Sheet (1 inch 188) in recent years. If it were possible to compare in detail the terraces which Mr. Sparks has demonstrated with the deposits shown on the (as yet unpublished) geological map no doubt many points of resemblance and of contrast would be clear. To a certain extent the same may be true of the older, much less detailed, mapping, in adjoining areas which have mostly never been covered by a 6-inch-to-the-mile geological survey. Mr. Sparks has questioned the interpretation of terraces at 180 feet and 130 feet as structural ledges formed on more resistant beds within the Chalk. For individual Chalk beds this criticism is bound to be valid, for the beds do not lie at even heights along the escarpment but are subject to the effects of dip and of folding in structures which, though gentle, account for considerable changes in the outcrops over wide areas. For instance, 6 or 7 miles east of Cambridge the Melbourn Rock at the base of the Middle Chalk lies above 100 feet O.D. but near Chippenham and Freckenham it has fallen to 50 feet O.D. and below. But the fall is not uniform, and near Landwade and Fordham folding both along the strike (north-east to south-west) and transverse to it has not only affected the Melbourn Rock but also the outcrops of Lower Chalk, Burwell Rock and Chalk Marl below it. Locally, nevertheless, both the Melbourn Rock and the Burwell Rock have influenced the accumulation of River Gravel deposits; indeed, at Snailwell, north of Newmarket, for example, these consist very largely of pebbles of abraded Melbourn Rock, against which the drift is banked, and elsewhere spreads of gravel rest on broad areas of Melbourn Rock and Middle Chalk in which it can be seen that freely circulating water has produced extensive solution phenomena which have disturbed the overlying drift.

In mentioning terraced deposits it is necessary to add that the field geologist seeks to represent on his map not the flats which often characterize the surface of the drift but the actual extent and relationships of the gravels, sands and loams, etc., laid down by rivers or, in some cases, attributed to other causes. When the river deposits of the Cambridge area are mapped out in this way it is found that they fall into four stages or terraces of drift and a fifth type of gravel occurs at higher levels. The terrace deposits may be separated one from the other by intervening solid rock or they may overlap one another. In most cases they are banked up against the solid or the next succeeding terrace, or are benched into the hillsides, so that the effective level of the terrace form is not the surface but the base of the drift, which may be more than 30 feet thick. Now, the terraces are graded to the present streams such as the Cam and, near Newmarket, the Snail. The latter being much shorter and rising in fact on the Chalk escarpment, its 4th Terrace gravels, for instance, are on the south near to 200 feet O.D. or touch this figure, while near Cambridge the corresponding deposits are at 50 feet to 75 feet above O.D. It would appear, then, that terraced river gravel deposits overlap the horizontal surfaces which Mr. Sparks has described at 180 feet and 130 feet O.D. and it is difficult to visualize what relationship these supposed marine features can bear to them; moreover, if marine conditions obtained, why are there no traces of characteristic marine deposits? I have seen some of the gravels in the northern fenland near March and Whittlesey where marine shells, oyster, cockle, periwinkle and whelk, are common, but there is no doubt about the nature of these gravels or their distinction from river gravels which also occur in that area.

The relationship of Mr. Sparks' four horizontal levels to the glacial deposits of the Cambridge district is another matter of much interest. Without attempting to unravel the difficult problems of correlating the various East Anglian boulder clays, it is possible to say that two glacial advances are quite clearly indicated. The main spreads

and channels of boulder clay are almost certainly all related to the earlier one, and that river development came after is shown not only by their dissection but also by the transverse course of the river, with a deep buried channel, across certain boulder clay filled east–west channels near Ely. Evidences of the later glaciation are the cold fauna and flora in gravels of the lowest terrace at Barnwell Station.

Mr. Sparks' conclusion that features of the present landscape may antedate glaciation agrees in principle with observations in East Anglia and in other districts (Professor Taylor, for instance, has drawn similar conclusions for an area of the East Midlands); but there was certainly a great deal of relief change during the development of the Cam and other rivers north and north-east of Cambridge, to judge alone from the extensive and orderly sequence of terraced deposits and the vast accumulation of flint, sand, chalk and other debris of denudation which they represent. This, we have seen, took place between two glaciations. The later one brought a cold climate but was not strong enough to do more than disturb *in situ* by solifluction the top layers of the existing gravel spreads. If ice had come at this late stage to mix them up for the confusion of the geologist he could have hoped for but little success in representing the separate terraced gravel spreads on his maps; and I would have had even less excuse to comment upon Mr. Sparks' stimulating researches in geomorphology.

Miss M. A. ARBER: I too should like to say how much I have enjoyed this paper. In connection with the difficulty of the Cam having cut such a wide valley, I think we are inclined to underestimate the powers of erosion which it possesses on occasion. It is of course true that in a general way the Cam confirms the National Fire Service's war-time signpost in Cambridge: "Static Water: River"; but after exceptionally heavy rain or melting snow, as in March 1947, it is surprising how much erosion both the Cam itself and even such minor tributaries as the Binn Brook can do. Such work could never be very great, but it is probably more than is sometimes supposed.

Mr. W. V. LEWIS (Geography Department, Cambridge): May I join in the chorus of praise of Mr. Sparks' lecture and add that it has been an even greater pleasure to work with him in the field? This infusion of "London geomorphology" has been a very welcome one at Cambridge. As to the size of the Ashwell branch of the Cam valley, this is an interesting point but is, I think, essentially a problem of Chalk scarp recession rather than of simple river erosion. This stream has a gentle gradient and active valley deepening must have ceased long ago. Valley widening can continue, however, if only by a slow solution of the Chalk, solution that may have been accelerated during the relatively short intervals of time when snow rested against the escarpment. A Chalk escarpment retreats slowly even when it is not being actively undercut by a strike stream. It is to the mechanism of Chalk scarp recession that, I think, we must look to account, in large measure, for the width of the upper valley of the Ashwell branch of the Cam. This line of enquiry would link up well with Mr. Sparks' most profitable studies.

Mr. B. W. SPARKS: It is gratifying to me for the paper to have stimulated this discussion. As several speakers have raised substantially the same points, I hope that I may be allowed to answer some collectively. Professor Wooldridge's axis of warping, as he defined it in this discussion and as mapped (Wooldridge and Henderson, 1955), lies to the east of any terraces mapped by me. Hence, my conclusion that they are unwarped would seem to be what should be expected, although it does not agree with Professor Taylor's hypothesis of warping in the east Midlands.

The question of the age of the 130-foot terrace is an open one. If the boulder clays on the Chalk uplands and on the western plateau are of the same (Gipping) age, the terrace could belong to the Great Interglacial, though I think that it is older. To my mind a number of too simple assumptions have been made about sea levels in interglacial periods, and I would prefer to await the results of botanical investigations now in progress before making more definite statements on this question.

I cannot agree with Mr. Clayton about the Ashwell valley and prefer to regard its anomalous width as an unsolved problem, being perhaps partly due to stream erosion,

partly to marine incursions and partly to processes of scarp retreat suggested by Mr. Lewis. It must be said, however, that where the terraces are preserved at the foot of the escarpment, that escarpment cannot have retreated much since their formation. The lack of boulder clay in the Ashwell valley, mentioned by Mr. Clayton, is, I think, partly due to non-deposition and partly to subsequent scouring. I presume that near the margin of an ice sheet, subglacial and proglacial meltwater streams must, in the main, occupy existing valleys and redeposit boulder clay largely as sorted material. Although this is only conjecture, it seems as reasonable as the assumption that an ice sheet must leave behind a uniform spread of boulder clay.

I was interested in Mr. Holmes' comments, as I have heard him discuss the gravel terraces north and east of Cambridge before. It is possible for later gravel river terraces to overlap in elevation earlier marine terraces if the stream starts in high ground behind the terraces. Lack of marine deposits is always a problem, though they may have been thin or non-existent in the first place, as may be clearly seen, for example, on the marine abrasion terrace east of Brighton at approximately present sea level. If the country rocks lack resistant constituents, as they probably did in the Cambridge district before the advent of the vast spreads of glacial material, subsequent uplift and dissection of marine erosion terraces may completely remove any traces of gravels which may have been formed on them.

THE PHYSIQUE OF WALES

E. H. BROWN

THE FIRST significant contribution to the study of the land forms of Wales was made one hundred and ten years ago when the Geological Survey published Ramsay's memoir on 'The Denudation of South Wales and adjacent English Counties.' [1] This was followed in 1866 by his 'Geology of North Wales.' [2] In the earlier of these works, Ramsay describes a "gently inclined plane," which he later refers to as the "high tableland." Above this upland surface rise the highest mountain crests such as Cader Idris, Plynlimon, Snowdon, and Pen y Fan; whilst into it have been carved the present river valleys of Wales. It has been cut across highly complex and powerful structures such as the Bala Fault and the Central Wales Syncline.

Within a few years, McKenny Hughes [3] subdivided the high tableland into two parts and the recognition of further substages has characterized most work since that time. The majority of authors have been primarily concerned with small areas; the notable exceptions are two comprehensive surveys by O. T. Jones [4, 5] and the statistical analysis of S. E. Hollingworth.[6] The latter showed that the most prominent maxima on the altimetric frequency curves for North and South Wales are at 320–340, 420–450, 525–626, 820–840, 900–960, 1025–1080, 1150–1350, 1450–1580, 1700–1775 feet. These are taken by Hollingworth to be indicative of erosion surfaces within each height range. To them must be added a "200-foot" surface described by Dewey,[7] Greenly,[8] Goskar and Trueman,[9] Miller [10] and others. Of the four highest in Hollingworth's list, three are broadly correlative with surfaces previously recognized by Keeping,[11] Sawicki,[12] and Goskar.[13] The highest would seem to be Ramsay's "high tableland."

Analyses of the long profiles of rivers, together with recent detailed studies, have generally supported Hollingworth's results.[14, 15, 16] But few of the published papers are accompanied by maps showing the distribution of the erosion surfaces. It was clear that no valid conclusions could be made concerning the denudation chronology of Wales until the whole country had been mapped.

Ramsay looked upon the "inclined plane" as the product of wave erosion, thus setting the fashion for a British school of thought which still has its adherents. Jukes Browne [17] was one of its leading protagonists and he deprecated the views of W. M. Davis [18] who introduced, with Sawicki, the subaerial peneplain concept as an explanation of the upland plains of Wales. Wooldridge [19] has been a leading proponent of the Davisian concept in Britain and has recently restated the case for their subaerial origin. A third hypothesis would make the tableland the product of erosion under arid climatic conditions in Permo-Triassic times. This was first suggested by O. T. Jones in 1930 and reiterated in 1951. If this is so, the resultant pediplain must have been buried by Mesozoic rocks so that it might later be exhumed, perhaps in Tertiary times, to form part of the present landscape. It is hoped that a study of the attitude and form of the surfaces mapped in the field will resolve the problem posed by these conflicting theories.

Parallel with this diversity of opinion, concerning the origin of the surfaces, mutually exclusive views of their age have arisen. The Permo-Triassic age suggested by Jones stands in contrast to Jukes Browne's postulated Cretaceous age whilst Davis and others thought them to be no older than the Tertiary.

Equally complex is the problem of drainage evolution. Strahan [20] said that the now discordant rivers of South Wales had been superimposed from a Cretaceous cover rock and this concept has gained wide acceptance.[21, 22] George,[23] on the other hand, has suggested that the rivers have grown by the periodic extension of their courses across emergent wave-cut platforms of Pliocene age. So far this difference of opinion

is unresolved. A study of the drainage pattern and the stages through which it has passed is fundamental to the solution of the problems of origin and age posed by the erosion surfaces.

Therefore, field mapping of the remnants of erosion surfaces was carried out on sheets of the Ordnance Survey one-inch-to-the-mile map series. A reconnaissance study of this type covering such a large area must be ultimately followed by work on the 1 : 25,000 or 1 : 10,560 scales, preferably river basin by river basin, but determination of the regional framework is regarded as a desirable prelude to such detailed studies. The survey was started in the Ludlow district far away from the sea and in an area previously unknown to the author, so that a degree of objectivity concerning the nature and origin of the erosion surfaces could be achieved. Profile views of hill tops and spurs are the basic elements in field work of this type. Although very desirable, it is frequently not possible to delineate a break of slope between one surface and the next when standing on or near it; only when it is seen across an intervening valley can the flats and breaks be satisfactorily recorded. Perspective can, however, create gently sloping surfaces in such views where none in fact exist, and it is essential to make sure that the features are being seen normally—*i.e.* at right angles.

A further technique employed was to find an erosion surface and to follow it as far as it would permit. It is, for instance, possible to follow the Low Peneplain from the Dovey valley south-westwards into Pembrokeshire thence eastwards to the Forest of Dean and northwards to the Clee Hills, passing from fragment to fragment without once being out of sight of the next remnant ahead or the one in the rear. If this method is used, correlations between one region and another are based upon the best evidence available, the continuity of the surfaces and not solely upon height. The junctions between successive surfaces were examined carefully and it is clear that what may seem to be a gently inclined plane on a section drawn from a map can often be shown to be two or more steps, with breaks of slope between, in the field. These techniques may be regarded as old fashioned, but handled sensibly they are not only adequate but sensitive tools. Success largely depends upon the ability to think three dimensionally not only about the present land forms but also of conditions as they were at the different periods indicated by the erosion surfaces mapped.

High Plateau.—Perspective views of skyline profiles in the Welsh uplands, from vantage points such as Plynlimon (1) * give the impression that there exists a widespread plain between 1700 and 2000 feet. This is also shown on the cartographic equivalent of such views, the composite profile. In Figure 2 the plain is traceable from a point south of Snowdonia (2) into Central Wales. South of the Old Red Sandstone cuesta of the Brecon Beacons (3) it is found in the South Wales coalfield. This plain was referred to by O. T. Jones as the "high plateau" [24] and that name is used here. It is Ramsay's "tableland," a term preferred by Jones in more recent years.[25] Rising above it are the major mountain summits which here will be called the "Monadnock Group"—to this belong such mountains as Snowdon (2), Cader Idris (4), Plynlimon (1), Radnor Forest (5), the Black Mountains (9) and Brecon Beacons (3). Cartographic devices such as the composite profile do not show the whole extent of this plain or the Monadnock Group and so these have been determined in the field. Figure 1 shows that even when the fragments which remain are represented in a generalized manner there is little of the High Plateau left. The continuity portrayed on the composite profile and in hilltop views owes a great deal to perspective.

As the High Plateau extends from the northern margin of Snowdonia (2) south as far as Craig y Llyn (6) in the coalfield, a distance of 110 miles, it must have been cut across a great variety of structural elements and lithological types. The Snowdon Syncline, the Harlech Dome, the Central Wales Syncline, the South Wales coalfield synclinorium, the Talyllyn–Bala Fault and the Church Stretton disturbance are the

* Numbers refer to features indicated on Figure 1.

more important of these structures. In the synclinal areas the relief has been inverted and it is here that the High Plateau is often best preserved. The surface is principally developed on Pennant Sandstone, Carboniferous Limestone, Old Red Sandstone and greywacke and volcanic deposits of early Palaeozoic age. These are the more resistant of a great variety of lithological types. It is clear that there is no simple structural explanation for the existence of the High Plateau.

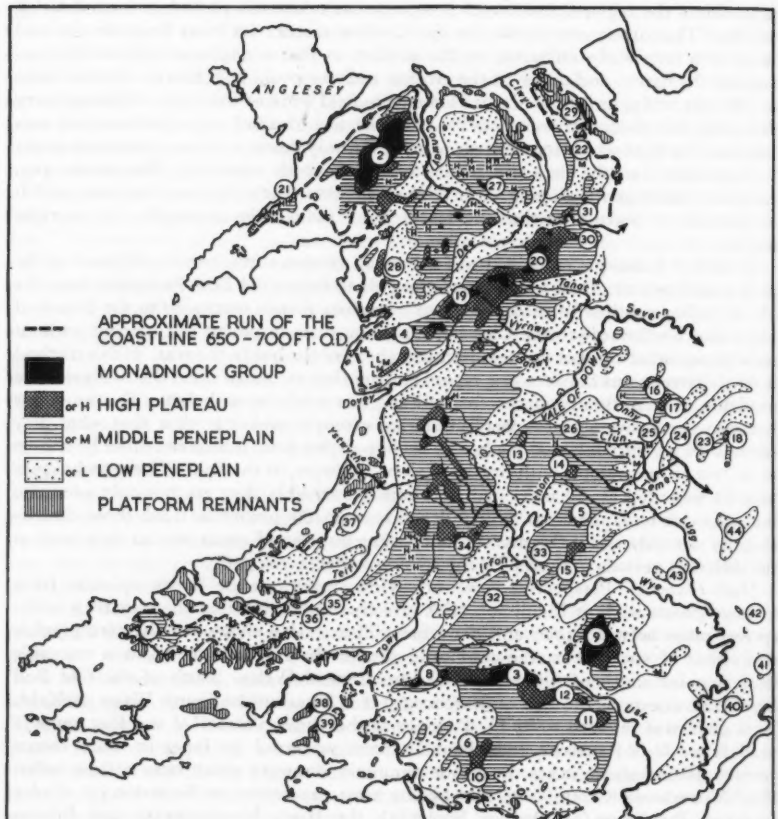


Fig. 1. The principal erosion surfaces of Wales

O. T. Jones regards this surface as having been warped from 1700 feet south of Plynlimon (1) down to the height of the coastal plateau in South Wales at approximately 200 feet.[16] In this view, the Prescelly Hills (7) and the whole of the Black Mountain (8)–Brecon Beacons (3)–Black Mountains (9)–coalfield (6) block are residuals rising above the down-warped surface. The composite profile, Figure 2, suggests that, on the contrary, the High Plateau may be traced from the vicinity of

Plynlimon (1) and Radnor Forest (5) into the coalfield upland surface without any radical change in altitude. The field evidence is no less convincing.

Plate 1 shows a peneplain surface cut across the Pennant Sandstone in the coalfield south of Craig y Llyn (6) and on Mynydd Llangeinor (10) between 1750 and 1900 feet. A surface at a similar height and also on the Pennant Sandstone occurs on Coity Mountain (11) between the Ebbw Fach and Avon valleys, Plate 2. Separated from these remnants by the vale on the Lower Coal Measures outcrop are Mynydd Llangattwg (12) and Mynydd Llangynidr, flat-topped mountains between 1700 and 2000 feet, cut across the Carboniferous Limestone, Plate 2. On the scarp face of the Brecon Beacons (3) are benches roughly coincident with the bedding of the Old Red Sandstone but accordant in height with the surfaces described on the Carboniferous rocks. Fragments are also found on the down dip end of three spurs in the Black Mountains (9). In addition there are some twenty summits within the supposed residual block which accord in height with these surface fragments.

The presence of such accordant summits and surface remnants is clear evidence of a dissected erosion surface between 1700 and 2000 feet which is in all probability a continuation of the High Plateau of North and Central Wales. If this is so, then it is a more extensive surface than Jones thought and it is not warped.

Some of the least dissected remains of the High Plateau are found south of Plynlimon (1) on the water partings between streams draining to Cardigan Bay and the Bristol Channel. Plynlimon, which rises above them, is a striking example of the monadnock form. Its convex crest, 2468 feet O.D., which crowns the long concave flanks of the monadnock, stands more than 500 feet above the surrounding High Plateau. The resemblance in form to Mount Monadnock in New Hampshire is very striking (Fig. 6a).

East of the Wye valley the long narrow summit surface of Rhydd Hywel (13) accords in height with the High Plateau as do a number of summits in the neighbourhood of Beacon Hill (14), the highest point in the Clun Forest. The same surface forms a discontinuous fringe around the summit of Radnor Forest (5) from where it can be followed southwards across Colva Hill to Red Hill (15). In the border country the Stiperstones (16), Longmynd (17) and Clee Hills (18) would seem to be fragments of a formerly much more extensive High Plateau as they are roughly accordant with its general height. The only suggestion of a surface fragment here is the smooth summit of the Longmynd.

Forming the base above which rise the summits of Cader Idris (4), the Arans (19) and Berwyns (20), is a much dissected surface which is similar in height and form to the High Plateau. It is traceable to the south along the main water parting to within sight of the High Plateau around Plynlimon (1). There are no direct links between the individual groups of surface fragments but there is no reason to doubt the fact that they all once formed part of a surface which was Wales-wide. North of the line of the Talyllyn–Bala Fault, the fragments are fewer and what evidence there is of the High Plateau is to be found in an accordance of summit heights.

From some view points, as on Figure 3a, these isolated fragments fit together in such a manner as to reconstruct the surface. Summits accordant with the High Plateau also occur in the areas peripheral to the mountain core as in the Lleyn (21) and Moel Fammau (22) (Clwydian Range).

Monadnock Group.—There is no general accordance of summit height amongst the Monadnock Group; they range from 2100 to 3500 feet. Greenly [17] suggested that those in Snowdonia, when viewed from Anglesey, subtend to an arc-like surface. A similar impression is obtained from view points south of Snowdon. An arc-like form is also detectable in the surface which can be drawn through the lower of the Monadnock Group summits in South Wales when seen from view points in the coalfield. The crest of such a surface would be at 2400 feet. Within the Monadnock Group as a whole the highest summits are in the north and south and the lowest are in Central Wales. Radnor Forest (5) has a definite summit surface at *circa* 2100 feet. If this fact

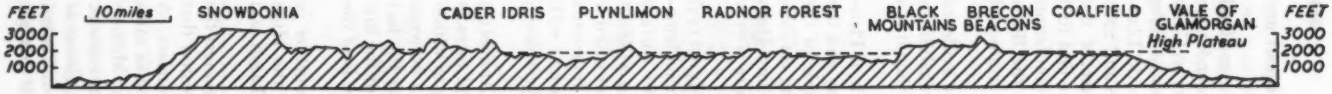


Fig. 2. North-south composite profile of Wales

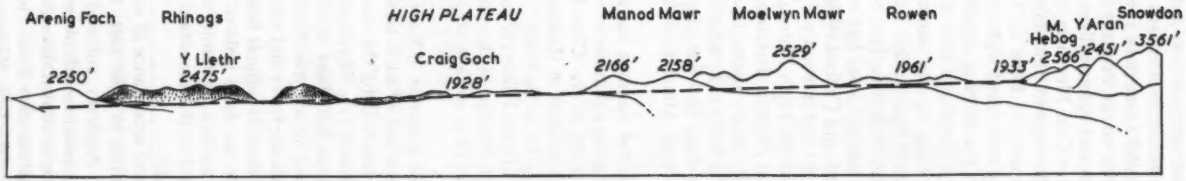


Fig. 3a. High Plateau south of Snowdon (2), seen from Mynydd Hiraethog (27)

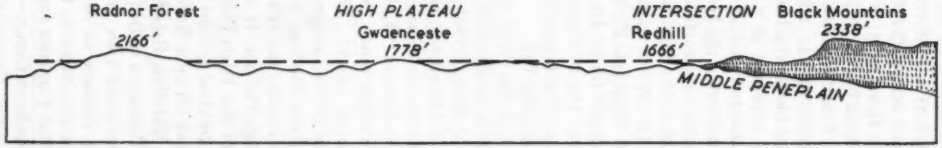


Fig. 3b. Junction between the High Plateau and Middle Peneplain at Red Hill (15), seen from Drygarn Fawr (34)

is taken in conjunction with the possible arc-like forms in Snowdonia and South Wales there is perhaps some evidence of a warped surface higher than the High Plateau. This may be termed the "summit plain."

Middle and Low Peneplains.—It is reasonable to suppose that if there are erosion surfaces lower in altitude than the High Plateau, they, like it, will be best preserved on the major water partings. Figure 4 shows the profiles of part of two of the major divides in Wales drawn originally to the horizontal scale of 1 inch to 1 mile. The vertical scale is exaggerated approximately fivefold. A close inspection of these profiles shows that in places the divide is almost horizontal. Such stretches are separated by more steeply sloping portions. The highest of the step-like forms is clearly the High Plateau, as for instance on either side of Plynlimon (F) and between Bwlch y Groes and the Berwyn range (J). Below this there is a surface between 1200

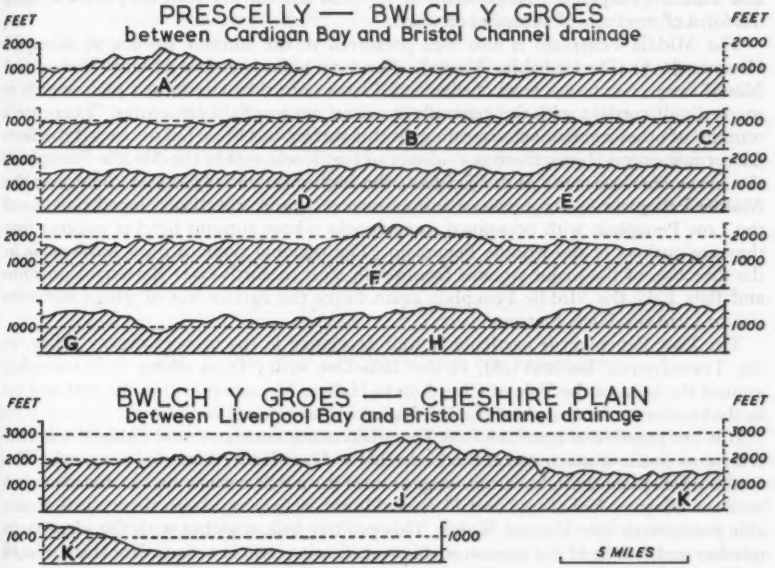


Fig. 4. Water parting profiles

and 1600 feet, well shown east of the Berwyns (K) and on the Towy–Teifi divide between Mynydd Llanybyther (B) and the head of the Camddwr (D). On the latter stretch it is divided into two portions; the first 1200–1350 feet, the second 1500–1600 feet with a break in slope between them at Halfway House (C). North of the Camddwr (D) is a series of summits rising to 1700 feet and over; these are outliers of the High Plateau which dominates the water-parting between Llethr Tirion (E) and Plynlimon (F). South of Mynydd Llanybyther (B) the profile falls from 1319 to 1000 feet within 7 miles, after which it fluctuates between 800 and 1000 feet for over 20 miles to the foot of the Prescelly Hills (4).

North of Plynlimon, the water-parting crosses the Tarannon plateau, 1500–1600 feet (G), and then a series of summits between 1200 and 1476 feet before climbing on to the High Plateau at Carnedd Wen, 1716 feet (H) and Tir Rhiwog, 1787 feet (I).

The surface or surfaces between 1200 and 1600 feet will be referred to as the Middle Peneplain and the surface between 800 and 1000 feet as the Low Peneplain.

Field mapping has shown that it is possible to trace these throughout Wales and

Fig. 30. Junction between the High Plateau and Middle Peneplain at the Usk (5)

the border country. In the Ludlow area the Low Peneplain occurs as a series of flat-topped accordant summits and spurs. It bevels the Psammosteus Limestone (Downtonian) cuesta (23) at the western foot of the Clee Hills and the Wenlock and Aymestrey Limestone cuestas of Wenlock Edge (24) and extends on to the Western Longmyndian north of Hopesay (25). It slopes from 1000 feet in the north-west down to 700 feet in the east. A short distance to the west the Middle Peneplain rises rather abruptly above it. The latter gradually slopes up from 1200 feet westwards across the Clun Forest Basin on to the Kerry Hills (26) at 1550 feet, without any perceptible break. At the inner margin the Beacon Hill (14) summits rise as monadnocks above the Middle Peneplain to the height of the High Plateau. The Low Peneplain may be followed up the valleys of the Onny, Clun, Teme and Lugg, in the form of valley-side benches, some distance upstream from the junction on the interfluves of the Low and Middle Peneplains. There seems little doubt that the surfaces, here at least, have the form of products of subaerial erosion.

The Middle Peneplain is also well preserved in the summit surface of Mynydd Hiraethog (27) (Denbighshire Moors). The very highest points Mwdwl Eithin and Marial Gwyn rise to the level of the High Plateau but they rise from a plain which is markedly discordant with the generally synclinal nature of the structures. There are a number of other monadnocks standing on this surface but these fail to reach 1700 feet. Closer inspection shows there is evidence of two levels within the Middle Peneplain, the lower between 1200 and 1400 feet, the higher around 1500 feet. Fringing the Middle Peneplain on its northern and eastern margin is a well developed portion of the Low Peneplain with occasional monadnocks whose summit heights suggest that they are outliers of the Middle Peneplain. The regional slope of these surfaces is in the direction of the major streams from south-west to north-east. Between Snowdon and Bala Lake the Middle Peneplain again forms the surface out of which summits rise to form the High Plateau.

The Low Peneplain is particularly well developed in the upper Conway valley, in the Trawsfynydd lowland (28), in the Bala-Dee valley from where it is traceable around the head of the Vale of Clwyd on to Halkyn Mountain (29) in the east and on to the similar surface north of the Denbighshire Moors (27) in the west.

It is not possible to trace the Low Peneplain continuously around either the north-eastern or south-western end of the Cader Idris–Aran–Berwyn ranges (4, 19, 20). The Middle Peneplain does, however, wrap around the north-eastern end of the Berwyns between Blaenau Uchaf (30) and Ruabon Mountain (31) and from thence it is traceable southwards into Central Wales. This positive link, together with the identity in number and height of the erosion surfaces, makes it possible to correlate the surfaces in North Wales with those in Central and South Wales.

South of the Berwyns (20) the Low Peneplain forms the surface on the interfluves between the Severn, Banwy, Vyrnwy and Tanat valleys. It is highly dissected and somewhat variable in altitude because there is rarely a true remnant of the surface to be seen today; it has been reduced to a number of only roughly accordant summit heights. This irregularity is probably a partial reflection of the rapid changes in lithology within the country rock. The surface is cut across a number of north-east to south-west folds, to which the Severn in the Vale of Powis and the middle Vyrnwy are adapted. The slope of the surface is with the rivers. It extends upstream to within a few miles of the headwaters of the Severn. West of the main water parting, across which the Middle Peneplain is developed, is the Dovey valley, another subsequent lowland within which the Low Peneplain was formed, particularly in the area south of Machynlleth.

Perhaps the most striking and extensive remnant of the Middle Peneplain is found on Mynydd Eppynt (32) where it slopes south-eastwards from 1500 to 1200 feet in 15 miles without any perceptible change in gradient. The surface is discordant with the north-east to south-west folds which disturb the overall south-easterly dip. The Low Peneplain has been eroded back into the heart of Wales along the Wye, Usk,

Irfon, Ithon and Towy valleys almost severing Mynydd Eppynt from the surrounding upland areas. The slopes of the individual units of the Low Peneplain are in all cases down valley.

East of the gorge section of the Wye, the flat-topped summits of Aberedw and Llandeilo Hills (33) carry the Middle Peneplain north-eastwards. At Red Hill, 1666 feet (15), there is an increase in slope beyond which the hill tops, such as Gwaenceste, 1778 feet, accord in height with the High Plateau. Northwards again, Radnor Forest (5) rises above the High Plateau. Seen in profile from the west the low angle junction between the two surfaces is quite distinct (Fig. 3b). On this evidence there would seem to be no justification for regarding the Middle Peneplain as a down-warped portion of the High Plateau.

The Low Peneplain in the Towy and Irfon valleys is clearly eroded along the general line of the Towy anticlinorium. It separates Mynydd Eppynt (32) from that part of the Middle Peneplain which cuts across the Central Wales Syncline in the upper parts of the Towy and Irfon valleys.

The Middle Peneplain has been cut back into the High Plateau along all the river valleys so that the latter surface has been dissected into a number of isolated blocks. Plate 3 shows the Middle Peneplain in the Elan and Claerwen valleys. The smooth concave slopes from the High Plateau lead down to an old valley floor, the Middle Peneplain, into which the rivers are deeply incised. South-west of Drygarn Fawr (34), which is a small monadnock rising above the High Plateau, the Middle Peneplain is the highest surface and the High Plateau has been completely destroyed. Between

Fig. 5. The ideal junction between two peneplains

these two zones, characterized, one by the Middle Peneplain pure and simple, the other by High Plateau remnants separated by the Middle Peneplain along the valleys, is a third zone where the Middle Peneplain is the dominant surface but on which there still remain monadnocks, lowered remnants of the High Plateau. A fourth zone can sometimes be found where the undissected High Plateau only is present. The ideal form of this type of junction between two peneplains is shown in Figure 5. In Figure 6b is a field sketch of the actual junction between the High Plateau and the Middle Peneplain. This type of junction is also characteristic of the boundary between the Low Peneplain and Middle Peneplain, Figure 6c. The flat tops of Mynydds Pencarreg and Llanybyther (35) are clearly outlying portions of the Middle Peneplain in an area where the Low Peneplain is more widespread. There is a marked resemblance between this type of junction and those described by Baulig in Languedoc [28] and the Blue Ridge–Piedmont junction in Virginia and North Carolina. The penetration of the lower surface so far into the higher one is characteristic of a peneplain produced by subaerial denudation, not that of a wave-cut platform.

The Low Peneplain is seen at its best between the Prescelly Hills (7) and Mynydd Llanllwni (36) and it can be traced up the Teifi valley on to Mynydd Bach (37) and northwards still further until it links with the equivalent surface in the Dovey valley. Plate 4 is a photograph of the Low Peneplain and shows the monadnock Prescelly rising above it. In this area there are signs that the Low Peneplain, as here defined 700–1100 feet, is in fact two surfaces. A similar subdivision of the Middle Peneplain has been shown to occur in some parts of Wales but in neither case are the subdivisions sufficiently distinct and widespread to warrant splitting either surface in a study of this general nature.

Within the Prescelly Hills (7), a number of summits and flattened spurs between

1200 and 1500 feet suggest that Prescelly Top, 1760 feet, rises above a fringing surface which is at the height of the Middle Peneplain. Thus the summit itself falls into place as a possible indication of the former spread of the High Plateau in west Wales.

From Prescelly it is a relatively simple task to trace the Low Peneplain eastwards across the Towy valley between Carmarthen and Llandilo onto Mynydds Llangyndeyrn (38) and Sylen (39) where it bevels the Carboniferous Limestone and Pennant Sandstone scarps, into the coalfield. In spite of heavy dissection it is possible to map spur flattenings and bevelled summits which indicate the presence of the Low Peneplain and Middle Peneplain throughout the coalfield region. It was these

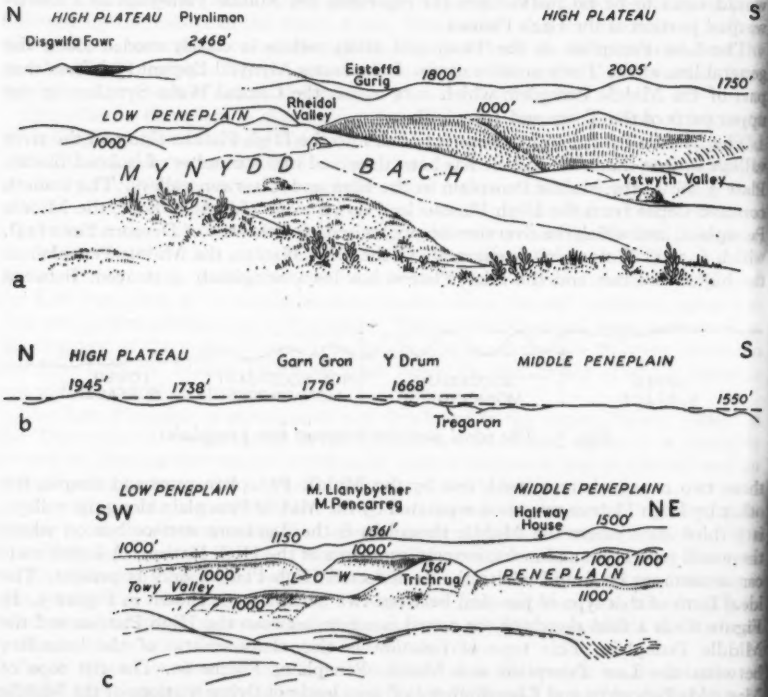


Fig. 6. Actual junction between the peneplains on the Towy-Teifi water parting, seen from (a) the north end of Mynydd Bach (37); (b) the south end of Mynydd Bach; (c) Black Mountain (8)

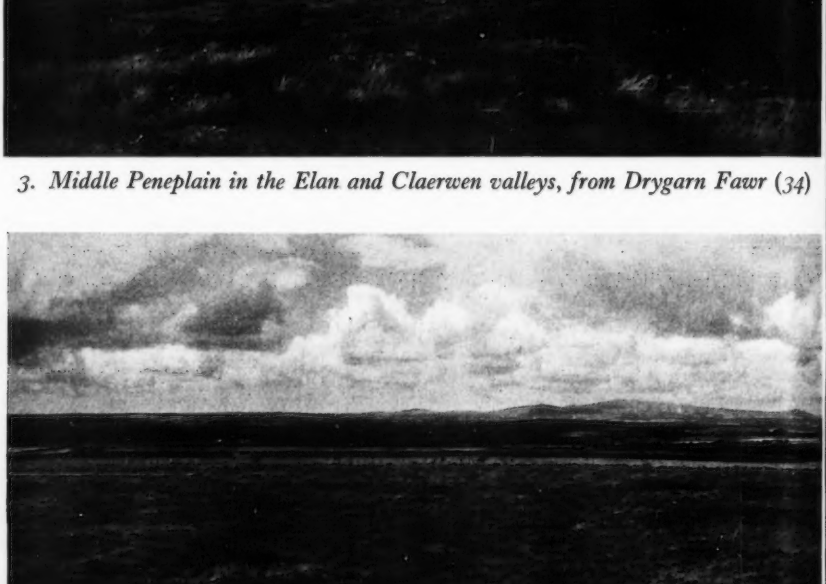
remnants that enabled Miss Goskar to detect surfaces at 1450–1500 feet, 1200–1300 feet and 1000 feet on projected profiles.[29] The first two are the two parts of the Middle Peneplain, the latter the Low Peneplain. Quite clearly, surfaces as widespread as these within the coalfield must be and are discordant with the faults and folds which diversify the structure of this synclinal area.

The surface which truncates the Forest of Dean basin (40) is also considered to be a well preserved eastward extension of the Low Peneplain. It can be traced still further east and north on to the flat top of the Silurian inlier of May Hill (41), the highest summits of the Woolhope Hills (42), on Silurian limestones and other summits in the Old Red Sandstone lowlands of Herefordshire at Mansell Lacy, Birley (43) and on the plateau east of Leominster (44).

1. The High Plateau south of Craig y Llyn on the Pennant sandstone

2. The High Plateau on Mynydd Llangattwg (foreground), Coity Mountain and Carn y Cefn.

3. Middle Peneplain in the Elan and Claerwen valleys, from Drygarn Fawr (34)



4. The Low Peneplain and Prescelly monadnock

The sequence of erosion surfaces is the same throughout Wales. There is nothing on the composite profile, the water parting profiles and more particularly in the field to suggest that any of the three peneplains described are warped in any way. Both Prescelly (7) and the Black Mountain–Brecon Beacon–Black Mountains–coalfield block (8, 3, 9, 6) show precisely the same sequence of peneplains as the rest of Wales, a fact difficult to reconcile with the concept of a single down-warped surface. The field mapping has shown a series of peneplains which meet one another at low angle junctions characterized by the penetration of the lower into the higher surface.

The resultant complex, interpenetrating, pattern as shown on Figure 1, is the first reason for believing that the surfaces are in fact peneplains. It is a pattern totally unlike any conceivable form of wave-cut surface or surfaces. The surfaces slope, where enough remains of them to be able to determine regional slope, in accordance with the drainage and although this may reflect the initiation of the streams upon emergent wave-cut platforms, this is unlikely to have occurred; for instance, on the Low Peneplain in the Severn and Bala–Dee valleys which are subsequent in nature and in such sheltered positions with respect to the sea. The monadnock zone type of junction described is characteristic of peneplains, not of the degraded cliff line between wave-cut platforms the foot of which must be at a uniform height. As W. M. Davis noted, the monadnocks show no convincing evidence of cliffing around their margins.[30] Nowhere have marine deposits been found on any of these surfaces although a considerable amount of time and effort has been spent looking for them. The submarine equivalents of these peneplains must have existed and it must be assumed that they lay beyond the present limits of the peneplains and were destroyed by the development of each successively lower surface.

The platforms.—The highest of a series of horizontal wave-cut platforms was recently described.[31] It has an upper limit of 650–700 feet and is traceable, with gaps, around the seaward flanks of Wales, Figure 1. It is thought that this resulted from the transgression of a sea to a height of just under 700 feet, principally across the Low Peneplain. There are some signs of platform remnants above 700 feet and much of what is here referred to as the Low Peneplain has been interpreted as of wave-cut origin. I am convinced from looking at these forms in the field that if the sea ever did extend above 700 feet it was only during a temporary phase and the land forms above that height owe little or nothing to wave cutting but most probably everything to the work of subaerial weathering, running water and later ice action.

The drainage.—Since the early years of this century the drainage of Wales has generally been regarded as superimposed. There are major elements, such as the Wye from its source to Glasbury, which are transverse to the structure. Strahan [32] suggested that the original drainage was initiated on a cover of Cretaceous rocks in South Wales. O. T. Jones in a recent paper [33] concluded that the original pattern was a radial one and that superimposition from such a cover rock was the most likely explanation of the transverse elements. T. N. George [34] earlier suggested the superimposition of the drainage by the extension of consequents across emergent wave-cut platforms in Tertiary times. If, as has been suggested, these "platforms" are in fact "peneplains" this hypothesis is not applicable, at least above 700 feet. Below that height streams have been extended across such platforms as has been shown in the case of Ystwyth [35] and the Conway.

By an analysis of stream alignments and cols across present-day water partings it is possible to deduce what was probably the original drainage pattern. This is shown in Figure 7. The significant streams are those which flow transverse to the structure and which may be, therefore, remnants of original consequents, and those which show marked adaptation to the structure and are presumed, as a class, to be later in origin than the consequents and to have broken up the original pattern through the process of river capture. Not all cols through divides are necessarily wind gaps; glacial meltwater over flow channels, fault notches, cols due to the retreat of a scarp face, or a

combination of these may all simulate them. The form and alignment with the drainage alone make it possible to assess the value of each col.

The original drainage pattern as deduced by these methods is radial, not from a point, but from a line which is approximately parallel to the present coastline of

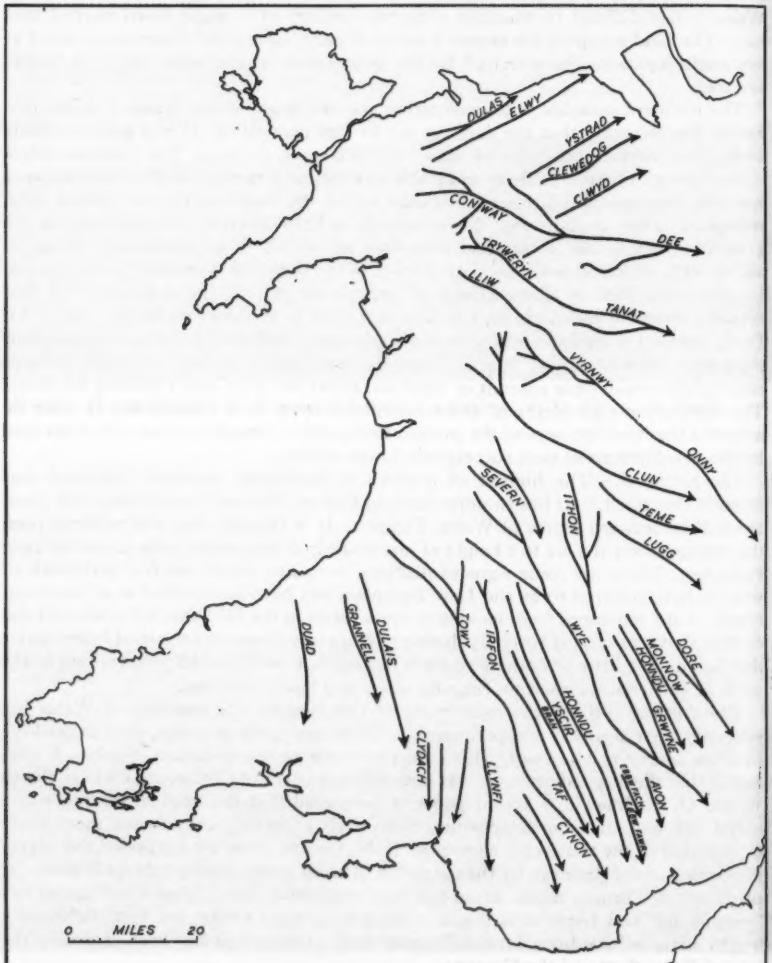


Fig. 7. The original drainage pattern of Wales

Cardigan Bay. There is no suggestion of a master stream flowing west to east; the Conway–Dee which Linton regards as the head stream of the proto-Trent [36] is the nearest but it is only one of the whole series whose direction varies from west-south-west to east-north-east in north-east Wales round to north-north-east to south-south-west in the south-west of the country. This pattern was probably initiated on the

eastern flank of a dome-like uplift whose western limits are not known. Neither is the location of the culmination clear from the evidence. The arc-like line traced by the sources of the reconstructed streams lends some credence to the possibility of down-faulting at the centre of the uplift as suggested by Cloos,[37] and Linton.[38] Such a line could be the successor, following divide retreat, of a fault scarp which resulted from rifting on the site of the Irish Sea. Alternatively, the apex of the dome and the sources of the rivers might have been on Mesozoic rocks which filled the site of the present Cardigan Bay. A gravity survey [39] has recently given results which suggest that Cardigan Bay, like Liverpool Bay, the Cheshire Basin, the Severn Basin and the Bristol Channel,[40] is the site of a depression in the Palaeozoic floor filled in with Permo-Triassic deposits, perhaps topped off with some later Mesozoic rocks. Such rocks would have been relatively easily removed by subaerial erosion and wave action.

Strahan, Jones and Linton have all regarded the cover rock from which this drainage was superimposed as of Cretaceous age and the evidence given here is perfectly consistent with this. The uplift which led to the initiation of the drainage probably took place, therefore, in early Tertiary times. There is independent evidence of Tertiary uplift in Wales. Dykes found in Anglesey [41] and up to a height of 2500 feet in Snowdonia [42] are regarded as Tertiary in age and most probably associated with similar intrusive rocks in northern England and Scotland. These dykes must have been intruded at depth even where they are highest today; otherwise extrusion, for which there is no evidence, must have occurred. The gravity surveys [43] have revealed large anomalies in North Wales suggesting Tertiary uplift of the order of several thousands of feet. In the Vale of Glamorgan the Mesozoic rocks are gently folded and Jones has suggested that this folding took place in Miocene times, as it has the en-echelon pattern associated with the movements of late Oligocene–early Miocene times in Southern England.[44] It is not possible at present to differentiate between the two phases of Tertiary uplift in Wales but it is clear that such movements did occur. If the drainage was initiated as a result of updoming early in the Tertiary period and if the disruptions of the radial pattern can be satisfactorily accounted for by progressive adaptation to structure, it would seem that the mid-Tertiary movements did not affect the pattern directly and that the drainage is to this degree antecedent to the later uplift. It is probable that by the mid-Tertiary the rivers were incised into the Palaeozoic rocks over much of Wales and that the uplift gave them greater erosive power which enable them to maintain their courses.

It has been shown that the peneplains in Wales have not been warped; their formation must therefore postdate the last earth movements which probably took place in the middle of the Tertiary period. All three peneplains are thought to be of Miocene and Pliocene age. The Low Peneplain is cut on its margins by a 600-foot platform which is reckoned to be the equivalent in Wales of the late Pliocene–early Pleistocene wave-cut platform of south-east England.[44]

If the High Plateau, in particular, or any of the peneplains, were ever surfaces on which Triassic or Jurassic deposits rested it is surely an amazing thing that the stripping has been so perfect that not one single remnant of such deposits can be found today and yet the surface on which they supposedly rested is still such a striking part of the Welsh upland scene. If Triassic and Jurassic rocks extended over Wales, as the drainage suggests some part of the Cretaecous probably did, then they were all at a level high enough above that of the High Plateau for them to have been completely removed, together with a slice of the Palaeozoic undermass, where the High Plateau was formed on Palaeozoic rocks. The surface on which these sediments rested must have been warped by the Tertiary movements and of warped surfaces there is no real evidence, unless it be the surface which can be described through the summits of the Monadnock Group, the "summit plain." If these are the remains of a real surface they may equally well have been formed in early Tertiary times as at any earlier period. In south-eastern England there was a marked time interval between the elevation of the

late Cretaceous sea floor and the deposition of the Eocene. This together with the whole of the Eocene and Oligocene was ample time in Wales for the removal of a Cretaceous cover rock, the superimposition of the drainage upon, and the erosion of, the Palaeozoic rocks beneath to form the "summit plain."

I should like to express my thanks to the Central Research Fund of the University of London for a grant towards the field expenses incurred during the mapping of the erosion surfaces.

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DISCUSSION

Afternoon Meeting, 29 October 1956

Before the paper the CHAIRMAN (Professor J. A. STEERS) said: Dr. Brown has already written papers on Cardiganshire and on the Ystwyth Valley and he has in proof a further paper; he lectured at Aberystwyth before coming to University College, London; he is quite *au fait* with the ground in Wales.

Dr. Brown then read his paper

The CHAIRMAN: I now call on Professor Miller to open the discussion.

Professor AUSTIN MILLER (University of Reading): I have listened to Dr. Brown's presentation with great interest, and I have had the good fortune to read the much longer exposition in his doctorate thesis although, unfortunately, I had not the maps by me on that occasion. I have also been supplied with a small map in anticipation of the discussion which is going to follow. I have myself been interested in the geomorphology of Wales and the Border country for about thirty years and, in a rather desultory way, in the high plateaus of Central Wales for about twenty-five years. But I have never brought myself to scan the landscape with the perseverance, intensity and, I might say, concentrated ferocity that Dr. Brown has turned on it in the last four or five years. I have never found a full and satisfying explanation of these perplexing problems, at any rate not one that I would dare to put forward with any degree of confidence. Therefore, I wish now to express my congratulations and thanks to Dr. Brown for his courage in coming to conclusions, however tentative they may be at this stage, and for the stimulation his work must give to all of us, English or Welsh, who are interested in and puzzled by the morphology of a region which is fascinating and beautiful and which we somehow feel hides, so far successfully, the key to the erosional history of mid-Tertiary times.

We have long been aware that there was a polycyclic relief not only below but also above the 600 feet level of the low plateaus which should receive more attention. It is clear in the Forest of Dean and on the bevelled scarps of the Wenlock and Aymestrey limestones along the Welsh Border, in the Middle Severn valley and in the Denbigh and Flintshire highlands. Always we have hoped to trace these surfaces back into the heart of the Welsh massif, but always we have been defeated by the irregularly sloping form of the blatantly obvious erosion surfaces, magnificent examples of which Dr. Brown has shown on the screen. Dr. Brown has identified the surfaces as peneplains of sub-aerial origin, and it is necessary to realize that even the most perfect peneplain

must have some amplitude of relief transverse to the direction of drainage, some undulating form, and must also have, in addition, some degree of fall towards the sea. The relief is not, and cannot be, quite flat in any direction. Dr. Brown has attributed to each surface an altitude range of 300–400 feet, with a separation of 100 feet between the upper limits of one and the lower limits of the next. I myself should not be surprised if actually these peneplain surfaces overlapped quite considerably in respect of altitude above sea level and were not separated by any interval at all. In fact, I should expect it. It was probably for this reason that Professor O. T. Jones in his careful statistical analysis failed to bring out any significant altitude maxima or minima; they are not to be expected when we are dealing with sloping and probably overlapping surfaces. Though they may appear in statistical studies of small areas, as shown by Hollingworth, they would cancel each other out over an area as large as the whole of Wales.

But can we regard the three peneplains as separate continuously sloping surfaces? The total distance over which they have been traced is 80–100 miles, and as their vertical range is 300–400 feet their gradients would be of the order of 4 feet per mile. Yet Dr. Brown has told us that the long south-eastward slope of Mynydd Eppynt, which falls 300 feet in 15 miles (20 feet per mile), is a good example of one of them.

The alternative to statistical method was to cultivate an eye for country, a method which is now rather old-fashioned, when everybody works to a precision of plus or minus 5 feet by means of an aneroid, but it was a method that served the early geomorphologists very well. It is not difficult to identify surfaces by eye and to trace each one across country as long as they are continuous, but difficulties begin and uncertainties of correlation arise when they are discontinuous and severed by subsequent erosion, as they so often are. There one may lose some confidence in correlation. I know that Dr. Brown has fully appreciated the dangers that lie here, especially in perspective illusion, and he has no doubt prepared himself in advance for criticism of that kind. The eye can never be level with the whole of the surface being mapped; it must be above some parts of it and below others. This limitation of the viewing method can be overcome in any one straight-line view, simply by climbing a hillside and keeping the eye on the level, but it is wellnigh insurmountable for the all-round view from any viewpoint or series of viewpoints, and there is always the possibility of being deceived. Now, since a peneplain has slopes in all directions it must be scrutinized and appraised round any radius up to the full 360°. Some misjudgment is inevitable, and the temptation is strong to see what one wants to see, especially after a hypothesis has been formed and is in process of being tested. One has to be a geomorphological angel to resist that temptation: Dr. Brown is the nearest approach to one that I have met. May I refer to the use of the word "peneplain"? Dr. Brown has said that all three surfaces are worthy examples of the Davisian peneplain, basing his verdict partly on ". . . the nature of the junction between them and the form of the residuals which rise above them." While I can accept this identification for the High Plateau from which the monadnocks arise, the other two, I suggest, cannot be, because a peneplain is an old-age form, long past maturity. As early as maturity the grading of slopes has reached the divides and thereafter the slopes do not depart from grade unless interrupted. Therefore, one peneplain cannot, I suggest, abut directly against another with a break of slope between as shown on the map with which I was furnished. My point is that the break of slope, if there is one, between one surface and the next, is evidence of erosion, and erosion is incompatible with a state of grade throughout, which is the *sine qua non* of the peneplain. Dr. Brown's "Low Peneplain" appears to be related to the major valley systems and to be more properly described as an upper valley facet; *i.e.* a post-mature valley floor into which the new incision is carved.

A question I want to put to complete the picture for my own satisfaction is this: has the author formed any picture of the palaeogeography of the time, or times, and in particular where does he suppose the coast lay? Does he accept the usual reconstructions, which are largely guesswork, of early Miocene times in Wales and, above

all, early Pliocene times? It is relevant to have an idea as to where the coast lay because one wants to know how far inland Wales then found itself, how far the rivers of the day had still to go to the base-level to which they were graded, and how far headwards into the higher valleys had the peneplanation advanced?

Professor S. W. WOOLDRIDGE: It is clear that we have listened to an important paper which can justifiably claim the title of synthesis, but a synthesis that, wide and extended though it be, is evidently based on very careful work on the ground, without which it would not command the respect which, in fact, it receives from us. The problem, particularly of the Welsh High Plateau, has been before us with a question mark, as Dr. Brown indicated, for many years. You cannot stand here even in the centre of the London basin in the Royal Borough of Kensington with any awareness of your environment without asking where, if you range further afield, are the great erosion surfaces, one of which lies 100 feet below the floor of this hall, another rather higher than 500 feet above our heads in mid-air. That is to say, the sub-Eocene surface, and that produced by the wearing down of south-east England after the Miocene folding. I have been certain for many years past that one or both of those surfaces must be elevated somewhere in the uplands of our western and northern districts. There is a common tendency amongst our geological friends not to see the force of that point because they are so fond of brushing aside and forgetting the 70 million years of Tertiary times. Not being very interested in these unprepossessing deposits beneath our feet they choose to assume that they can ignore the fact that Wales, like the rest of Britain, was shaped and carved in Tertiary times. The only place in which one can find a chronology of Tertiary times is in the south-east and the sequence of events adduced elsewhere has to be broadly concordant within the confines of this small island.

I was waiting for Dr. Brown's conclusion to hear, on mature reflection, what dates he would assign to his surfaces. On the whole, I am prepared, with some quite private doubts, to agree with his final verdict. I would be a little happier if one or more of these surfaces was demonstrably warped. I take Dr. Brown's point that it may be a summit surface. If there is an early Tertiary surface in Wales it is considerably warped. I reject the notion that the High Plateau of Wales comes down to the coastal plateau at 200 feet. The two surfaces have, in my judgment, nothing whatever to do with one another. There I am sure Dr. Brown is right.

The CHAIRMAN: I call now on Mr. Clayton who has worked in the Nottinghamshire and Derbyshire area.

Mr. K. M. CLAYTON (London School of Economics): My memory goes back to some remarks by Professor Wooldridge as to the way in which people in this country pretend to shut their eyes to the possibility of eustatic changes of sea level. We have met before these heights which Dr. Brown has mentioned. I have seen them in the Pennines and elsewhere so, I am sure, have others. There are wide lowland plains between these uplands, but the time is coming when correlation will have to be attempted. In that context I would like to refer to the Middle Surface. It seems to me that Dr. Brown's criterion in choosing his High, Middle and Low Peneplains, that they should be Wales-wide, is really a little too harsh. This Middle Surface has quite a wide height range, yet in many different places, scattered all over Wales, it is clearly subdivisible. I wonder whether the criterion "Wales-wide" is not too rigorous; the division appears in many parts of Wales, and should we not regard it as two separate surfaces? There is one other point. Looking at the detailed maps of the surface remnants I was impressed by the dominance of what seemed to be the north-east south-west pattern of those remnants, particularly of the monadnocks. This presumably is something to do with the trend of the Caledonian rocks of the area, and perhaps Dr. Brown could comment on this.

Dr. MARJORIE SWEETING (St. Hugh's College, Oxford): We are very much indebted to Dr. Brown for having the courage to bring forward the paper on Wales when some are a little more hesitant in putting "the cat among the pigeons." I do not

think anyone can deny that these erosion surfaces are largely of Tertiary age. I think Greenly put the evidence in a paper in 1938 when he discussed the age of certain dykes in Snowdonia. That seemed to me to be very conclusive evidence from the geological point of view. I am somewhat concerned by what Professor Wooldridge has said about these surfaces not being warped and also not related to the major fault lines which we know occur in Wales. I do not know the Welsh district particularly well, but it can be shown in the Yorkshire area, which I know better, that Late Tertiary and even possibly Pleistocene faulting has occurred along the margin of the Askrigg block. I wonder if that has happened in Wales? I cannot believe that Wales has been pitched high up without any differential movement. The idea that there has been no differential movement in Britain since the Mesozoic is probably not correct. I agree with Professor Miller that some of our thinking in regard to this matter is very subjective. I would like to see someone take up a real study of the glacial deposits of Britain to see whether we could find anything which might throw light on the Cretaceous cover problem. I would like to express thanks to Dr. Brown for putting the evidence as he sees it before us, and to congratulate him on his paper.

Mr. RONALD WATERS (University of Exeter): Dr. Brown's interpretation of the upland plains of Wales would seem to mark a signal advance towards a rational explanation of the undulating plateau surfaces of highland Britain. I have been particularly interested in the way in which he has been able to group his carefully mapped flats into larger morphological units. In the past we seem to have been plagued with a multiplicity of erosion surfaces wherein the significance of individual flats has been greatly overrated. It is gratifying to see how these individually mapped flats can be grouped into larger units each of which is clearly indicative of a major stage in the evolution of the Welsh landscape. By interpreting these larger units as peneplains Dr. Brown has struck a much-needed blow at the long-distance correlation of erosion surfaces on the basis of height above sea level, and for that reason I feel a little hesitant to point to correspondences between the erosion surfaces of Wales and the plateaus of South Devon. However, the weight of evidence seems to suggest that the equivalent of Dr. Brown's Low Peneplain is present all around Dartmoor whence it can be traced with certainty into east Devon and across the Dorset border to the margin of the Hampshire basin where it is seen to correspond with what Professor Wooldridge and Professor Linton called the Mio-Pliocene peneplain. Its sub-aerial origin is suggested by the variations in height of its upper limit and by the penetration of its upper portions into the Dartmoor upland as valley plains, the most extensive of which rises to 1200 feet in the Dart basin. On the other hand its lower limit is nowhere very far below 750 feet. There I think any attempt at correlation must end because there appear to be no extensive base levelled surfaces between the equivalent of the Low Peneplain and the summit plain of Dartmoor. The latter would seem to have been tilted southwards; if so, it must pre-date the unwarped surfaces at equivalent altitudes in Wales. Finally, I congratulate Dr. Brown on the completion of this most important piece of research which it is hoped will encourage others to cover the ground north-westwards from the peneplain on the Berkshire Downs to the Welsh border.

Professor D. L. LINTON (University of Sheffield): I, too, would like to offer congratulations to Dr. Brown on his paper, and particularly on the courage that must have been required to set out on this large synthetic piece of work, and on the scale with which it has been carried through. As to the method Dr. Brown has adopted, I had the advantage of discussing the work with him before the lecture and of seeing his diagrams and photographs. A point which may not have been sufficiently emphasized in his presentation this evening is how much his conclusions depend on what he has seen on the ground rather than what he has derived from maps. Inevitably, in presenting the matter in cartographical form he has dwelt upon areal relations, but that is a little false because, as I understand it, the way the work progressed was by tracing particular elements of the landscape continuously from one viewpoint to another. I

commend his method; in fact, I believe it to be the only one as yet open to us which allows us to follow a surface which is now represented only by detached remnants and was originally a sloping, river-cut surface, or a plain which has later been warped. Other methods, even before we begin to work on them, tend to correlate by altitude and prejudice the results. So I think the method adopted by Dr. Brown is important and I hope it will be pursued. Nevertheless, it must not be assumed that any finality attaches to this statement. Valuable as this synthetic presentation is, it cannot be accepted by any true scientist without re-examination of the ground. The work must be repeated in detail in certain regions which appear critical. I have a feeling that such work in the upper parts of the Severn basin would prove useful.

I agree with Professor Miller in objecting to the use of the word "peneplain" as applied to lower surfaces. The High Plateau may well be a peneplain in the Davisian sense of the word, the product of a largely completed cycle of erosion that has resulted in the destruction of the greater part of the relief. But only with the highest surface can we reconstruct a landscape which can be said to correspond to that picture. Let us suppose that all the material that has been eroded below the level of Dr. Brown's "Lower Peneplain" were to be put back so that we could walk continuously upon the surface which he has reconstructed for us on his maps, and could see the landscape as it once was, I do not think we should call it a peneplain but a landscape of mature valleys and bold uplands.

I could not help thinking, while listening to Dr. Brown and looking at his photographs, in terms of some Scottish landscapes. Anyone who crosses the Border, gets out of the train at Blair Atholl and ascends the slopes on either side of the valley, will find himself standing on an upland surface rimmed round by highlands. That surface rises gradually to the north and west and is enclosed on the east and south by the quartzite ridge of Ben Vrackie. Here is virtually a closed basin that can only have been base-levelled by streams. Its outlet lay over the sill of the modern Pass of Killiecrankie. Beyond the steep enclosing northern rim of the basin at 2500 feet or more lies one of the more striking and extensive expanses of the Grampian summit surface. These features of the Perthshire highlands so strongly resemble, but at higher altitude and with greater difference of altitude between the two surfaces, the relations which Dr. Brown describes between his Middle and Upper surfaces, that I cannot help thinking that they reflect the same kind of physiographic history. I, therefore, welcome very warmly Dr. Brown's interpretation but hope his work will be followed up by the detailed studies that no one man could possibly accomplish.

Mr. S. GREGORY (University of Liverpool): It was with considerable interest that I listened to Dr. Brown, especially as, for the past four years, my colleague H. R. Wilkinson and I have spent part of our time doing just what Professor Linton suggested should be done, *i.e.* carrying out a completely independent survey of part of Wales, especially concentrating on that through valley of the proto-Dee from Snowdonia to the Cheshire plain.[1] Our general conclusions are largely the same as those of Dr. Brown, both as regards the nature of the surfaces, especially the fact that they are sub-aerial in origin and are not warped, and also as regards the dating and general relationship of these surfaces. On the other hand, on the basis of more detailed work in a more restricted area, the Middle Peneplain does appear to be two separate levels, especially if one traces it along the proto-Dee. Apart from these two distinct levels within the Middle Peneplain there is in both the Dee and upper Conway areas yet a lower one which is the result of river capture from the north. River capture, in fact, is often the cause of these local differences in the number of levels.

As regards cartographical analysis, the 1:25,000 O.S. maps of North Wales were studied with every single summit taken off and plotted on a distribution diagram. The net result was that, up to 1000 feet, the maxima came everywhere at those contours

[1] Wilkinson, H. R., and S. Gregory, "Aspects of the evolution of the drainage pattern of north-east Wales," *Liv. Man. Geol. Jour.*, 1 (1956), pp. 543–58.

that are actually surveyed, namely, at every 100 feet. Marked minima occurred at the 75- and 25-foot contours and secondary maxima at the 50-foot contours. Above 1000 feet the summit contours seemed rather more reliable.

There are also a few points I wish to raise concerning the drainage pattern that Dr. Brown postulates. He showed the proto-Dee as a unified river at the Low Peneplain stage, but by tracing the valley-side benches it becomes clear that the capture of the upper Conway by the lower Conway was effected during the Middle Peneplain stage, since when the drainage of the Upper Conway has been via its present exit and not along the Dee. Moreover, the Dee, as postulated by Dr. Brown, was rather short of north-bank tributaries. From the remnant surfaces in the valleys draining south from the Denbigh Moors, in the upper Vale of Clwyd and along the upper Alyn, one must assume that drainage was southwards to the Dee rather than eastwards, and since then having been reversed to flow northwards.

Finally, I would like to raise the question of the 650–700-foot levels in north-eastern Wales. Along the Vale of Clwyd and over the limestone south of Prestatyn they grade readily upstream into terrace remnants, so that although one may say that the sea covered these areas during its transgression, the flats themselves may well be river-cut rather than marine-cut, with at most a later marine trimming.

Mr. R. J. Rice (Queen's College, Dundee): I am pleased to have this opportunity of adding my congratulations to those already offered Dr. Brown. I had the privilege of spending several days in the field with him and can testify to the skill, the enthusiasm and the patience with which he faced the enormous task of studying the whole of Wales. In a detailed study of the upper Wye basin between Plynlimon and the Black Mountains I came to conclusions closely similar to those of Dr. Brown. Yet I have some sympathy with Professor Miller's remarks concerning the tracing of surfaces merely on the basis of their height. This is a dangerous procedure in the case of marine-cut platforms; it is doubly dangerous in the case of fluvial features. In studying the Wye I worked upwards from the lowest, best preserved stages. I found, as might be expected, that the successive stages decreased in gradient. However, none of the gradients I reconstructed was as low as those postulated by Dr. Brown. It seems to me that some of the surfaces described by Dr. Brown have remarkably little slope. For instance, fragments of the High Plateau occur at a height of about 1700 feet south of Plynlimon and at almost the same height near Abergavenny. With Professor Miller I would agree that a peneplain should have a certain down-river slope, and correlation of the above fragments seems to me to raise gradient problems. Moreover, I feel we should be very sure in our own minds about the form of a peneplain to be expected before we say that a particular example is not warped. In the case of the High Plateau there appears to be a striking difference in the slope along the Wye valley and that along the proto-Dee where the surface falls some 300 feet in 10 miles. Mr. Clayton referred to the steep dip-slope of the Mynydd Eppynt. After examination of the ground I concluded that the dip-slope is actually composed of two surfaces, a summit one at about 1500 feet and a lower one at about 1300 feet. In the upper Wye valley I recognized more stillstands than Dr. Brown. For instance, the Middle Peneplain is almost certainly dual in South Central Wales and I was especially interested to hear that the same is the case in the Dee valley. Whilst I also have minor reservations of detail about what Dr. Brown has said, I should like to conclude by reaffirming my belief in his basic conclusions.

Professor W. G. V. Balchin (University College of Swansea): I have been greatly interested in Dr. Brown's paper for two reasons. On the one hand, I have now the responsibility of introducing a large number of geographers to the landscape of Wales, and on the other hand, many of you will doubtless recollect that some four years ago in this hall I tried to do for Exmoor what Dr. Brown has done for Wales. Although we have worked independently the high rate of correlation between the two areas is, I think, significant. At the lower levels we are in close agreement and I have been particularly impressed by the emphasis given by Dr. Brown to the topographic

changes which occur round about 700 feet. I also found this in Exmoor and Professor Linton has emphasized its importance elsewhere. Above this level a series of erosion surfaces may be located on both sides of the Bristol Channel, but Dr. Brown would have us believe that his Lower Peneplain sequence is of sub-aerial origin, whereas the evidence of the sequence from Exmoor points to a submarine origin. This is perhaps the only serious disagreement, for Dr. Brown's sub-aerial Welsh Middle Plateau appears to parallel the sub-aerial summit or envelope surface in Exmoor. The emphasis placed by Dr. Brown on sub-aerial origins above the significant 700-foot level may not, however, be irreconcilable with evidence elsewhere since any surface of submarine origin will eventually be modified by sub-aerial agents. There is also the problem of the known Continental Miocene Transgression to be accommodated somewhere. Perhaps greater attention should be directed towards the base levels of control which emerge from a study of the surfaces. In conclusion, I should like to congratulate Dr. Brown for applying himself so assiduously to such a large piece of territory and for bringing his investigation to such a successful conclusion in this most interesting and stimulating lecture.

Dr. C. EMBLETON (Bedford College): I have found Dr. Brown's lecture especially interesting, since my own geomorphological work has been concentrated in North Wales. I agree that in Denbighshire and Flintshire these upland surfaces are most striking.

I should like to make three comments on Dr. Brown's lecture. First, I also have come to the conclusion, in north-east Wales, that the upland surfaces are sub-aerial in origin, and their irregularities of relief sometimes make it possible to reconstruct in outline the old drainage patterns which existed on their surfaces. I am not convinced, however, that Dr. Brown's three-fold sub-division is applicable to all parts of Wales, and it may be in some areas that one single peneplain may have a greater range of altitude than the three or four hundred feet suggested by Dr. Brown. For example, I have recently been working on the Elwy drainage system in Denbighshire; here, there are definite traces of an old river-system flowing mainly northwards to the region of the present Irish Sea. The reconstructed profiles of these rivers generally start as high as 1300 feet, and fall without break to 900 or 1000 feet above the present coastline. Such a range of altitude is overlapping both Dr. Brown's categories of Low and Middle Peneplains. Further, I believe it quite possible, as Dr. Sweeting mentioned, that some at any rate of these upland surfaces have been affected by faulting, particularly in the neighbourhood of the Vale of Clwyd. For these reasons, I am not entirely convinced that Dr. Brown's method of correlation of these surfaces by altitude above present sea level is valid.

Secondly, referring to his maps of original drainage patterns, I cannot agree that the generally eastward flowing section of the River Elwy represents one of the oldest original streams surviving. My present work indicates that its northward flowing tributaries (Derfyn, Cledwen, Aled, etc.) are definitely older, and that the main Elwy below Llangerniew approximately is a later fault-guided stream which has intercepted these old northward flowing streams. Doubtless, modifications elsewhere to Dr. Brown's map of the original drainage pattern will become necessary with further work, but I believe that most of its principal features, such as the Rheidol-Teifi, are acceptable.

Finally, I feel that Dr. Brown might have said a little more on the effects of glaciation on the upland surfaces. The amount of actual lowering by erosion can, of course, be little more than guesswork in most cases, but there are many places where drift (together with peat) may mask considerable irregularities in the underlying rock-surface, and where it is extremely difficult to distinguish between areas of thick drift and those with merely a superficial covering. In my experience, it is in the case of the lower erosion surfaces that drift deposits give rise to most difficulty. (*Written contribution to Discussion submitted later.*)

Dr. E. H. BROWN: Thank you very much for your kind reception of this paper. I

am no angel, geomorphological or otherwise; perhaps it would be truer to say that only a fool would step in where angels fear to tread. Field experience in North America, particularly in the Appalachians (the type area of the peneplain) in the past few years has conditioned me to think in terms of much larger regions than is usual amongst young British geomorphologists.

It is possible, as Professor Miller says, for two peneplains of the same age to be at very different altitudes, so that an older surface in one area may be lower than a younger in another. Davis suggested that the Piedmont surface of the eastern U.S.A. was identical in age, with a much higher surface in the Blue Ridge province.[1] This arises where the two erosion surfaces are in different drainage basins, perhaps on rocks of markedly different degrees of resistance to erosion and certainly at differing distances from base level, so that the drainage divide between them is distinctly assymetrical. In a small area like Wales, such large differences in altitude have not developed because the drainage divides are nowhere so assymetrical as in the southern Appalachians. However, as Mr. Gregory described, he and Mr. Wilkinson[2] have been able to show in the case of the Dee and Conway basins that the ultimate result of such assymetry is the capture of the drainage in the higher basin by that in the lower and the production within the higher erosion surface of a lower one which is nevertheless of the same age as the higher in the sense that they are both graded to the same base level. In this way are erosion surfaces increased in number without any change in base level. The differences in altitude involved in such cases are of the order of 100–200 feet and are only found between surfaces of the same age in headwater regions. A short distance down the valleys the equivalent surfaces are at approximately the same height above present base level.

The subjective element in work of this type is well known. I have indicated in the written paper the precautions taken, the principal one being, as Professor Linton remarked, the pursuit of each erosion surface, as an individual unit and not correlation of one fragment with others on the basis of their heights. Professors Miller and Linton have objected to the application of the term peneplain to the Middle and Low surfaces. Locally, either may be the summit surface, as the High Plateau is for Wales as a whole, and in such a situation they merit the term peneplain, "an almost featureless plain." Further inland they are surmounted by the higher steps of the staircase of erosion surfaces. In the United States, these would be called "straths" or "berms." It has never been the practice to use these words in a restricted geomorphological sense in Britain and I have no desire to start a fashion. They could perhaps more satisfactorily be called partial, incipient or embryonic peneplains.

There would seem to be a general desire to split the Middle Peneplain. Mr. Rice says that the Mynydd Eppynt summit surface which I have taken to be one of the best remnants of the Middle Peneplain and not capable of ready sub-division can, in fact, be so divided. I am almost certain that if I had been mapping on the 6 inches to 1 mile scale, I should have agreed with him and have probably mapped half a dozen more sub-stages into the bargain. Therein lies the danger of splitting. If Wales is considered as a whole, I suggest that the three peneplains described are a sufficient and adequate statement of existing conditions.

Mr. Clayton remarked upon the alignments of the Monadnock Group. These reflect the fact that the highest mountains are preserved on the most resistant rocks in areas which, soon after superimposition of the drainage, became drainage divides as a result of river piracy during the process of adaptation to structure. They are, therefore, parallel to the structural trend. The Cader Idris–Aran–Berwyn range parallels the Bala Fault along which an early subsequent cut back to capture much of the radially disposed drainage. The east-west line of Monadnock Group summits in South

[1] Davis, W. M., "Stream contest along the Blue Ridge," *Geog. Soc., Philadelphia, Bull.* 3 (1903), pp. 213–44.

[2] Wilkinson, H. R., and S. Gregory, *op. cit.*

Wales is along the scarp crest of the southerly dipping Old Red Sandstone—in this instance an Armorican structural trend.

In reply to Dr. Sweeting, a whole series of wave-cut platforms up to an altitude of 700 feet above present sea level around the coasts of Wales have so far not been shown to be warped or faulted in any degree whatsoever. This means that as far as the evidence goes, and it is now quite extensive, there has been no resultant differential movement in Wales since the beginning of the Pleistocene period. Tonight I have tried to show that the evidence from the ground above 700 feet suggests that we may extend this period of stability back through Pliocene and Miocene times to the last earth movements, those of the Mid-Tertiary.

It is highly unlikely that the Cretaceous deposits, which are presumed to have extended over Wales, could have become incorporated into the Pleistocene drifts if, as I have suggested, the sub-Cretaceous surface passed well above the present mountain tops of Wales. Erosion to a depth of the order of 3000 feet, and perhaps much more, supervened between the uplift of the Cretaceous sea floor and the onset of the Pleistocene ice sheet. There was more than ample time for the removal and complete destruction of what was probably only a thin deposit and almost certainly not chalk containing durable flints.

I am interested to hear Mr. Waters' and Professor Balchin's comments upon similarities between Wales and the South-west Peninsula. I am disappointed rather than surprised to hear that on Dartmoor there is nothing in the way of a base-levelled surface above the one which is probably the equivalent of the Low Peneplain, especially as there are a series of such surfaces in Exmoor, described by Professor Balchin. I would prefer not to attempt to relate the flights of surfaces on the two sides of the Bristol Channel but merely to take note of the intriguing similarities between the field evidence and the different interpretations put upon them in the two regions.

In reply to Mr. Rice, I may repeat that height above sea level was not the criterion upon which the correlation of surfaces was made, but continuity in the field. I agree that the High Plateau shows little slope, but that is what might be expected on an unwarped, widely developed peneplain. The Mio-Pliocene peneplain of southern England is equally flat and extensive.

In reply to Dr. Embleton, the graded segment on the long profile of a river relating to any particular erosion surface on the interfluves will always be higher above present sea level than the erosion surface itself. This is due in part to the relatively rapid headward movement of knickpoints. To quote two examples, the graded segment on the Ystwyth relating to the 400-foot erosion surface in Wales extends from 710 to 901 feet; whilst on the Irfon, George showed that the 800-foot base level is represented on the long profile by a graded reach between 1390 and 1560 feet. I await with interest further results of Dr. Embleton's detailed work upon the drainage of north-east Wales, but only a stretch of 3 miles on the Elwy is structurally guided. The events of the Pleistocene period have had a profound influence upon these pre-glacial erosion surfaces. On the present scale of operations, this is of lesser moment than in more detailed local studies. I am continually amazed that it is possible by dogged persistence to reconstruct, however imperfectly, the major stages of the pre-glacial evolution of the Welsh mountains and valleys in spite of the later destructive and depositional activity of several ice sheets.

The questions of late Tertiary palaeogeography raised by Professors Miller and Balchin are perhaps the most difficult to answer. No Miocene rocks are known to outcrop closer to Wales than in Brittany and Cotentin, 160 miles away. The Breton Gulf in the Middle Miocene may have been linked by a proto-channel with the North Sea Basin of deposition. To the north and west of these marine basins lay the British land mass considerably folded and uplifted by the Alpine earth movements. There is little evidence to suggest that the Middle Miocene transgression, which in comparison with those of Upper Cretaceous or even Neogene (Eocene and Oligocene) times was very limited, ever penetrated within the confines of the British Isles. The St. Erth

Beds in Cornwall are now regarded as Pliocene and the age of the Boxstone fauna of East Anglia is still a matter of opinion. In Early Pliocene times (Diestian) a transgressing sea apparently extended into east Kent and the Lenham Beds were laid down on its floor. This was followed by the deposition of the Coralline Crag in East Anglia. The transgression culminated in Early Pleistocene times (Red Crag) in the cutting of the wave-cut platform at about 600 feet in south-east England and the deposition of the Red Crag deposits in East Anglia and upon the platform in the London Basin. It is thought that the 600-foot platform in Wales is the equivalent of the Early Pleistocene feature in the south-east, but that no Pliocene sea ever penetrated Wales.

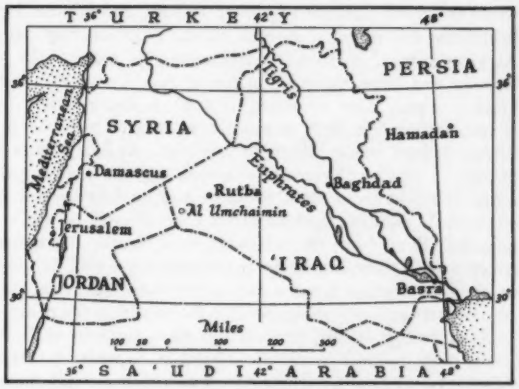
It is, however, conceivable that the coastlines of High Plateau, Middle and Low Peneplain times lay where any of the erosion surfaces lower in altitude than these are now found and that they were destroyed during the ensuing periods of planation. In view of the foregoing discussion of the palaeogeographic conditions in Mio-Pliocene times, this is unlikely and the rivers draining Wales in these periods had anything up to 140 miles further to travel to reach base level after they had left the present confines of Wales. I think that even after the base level fell, the peneplain graded to that level continued to develop at its inner margin at the expense of the next higher one. But in the absence of any continental deposits which have been truncated during this continued development, it is not possible to say, for instance, how much of the Middle Peneplain of today has developed at the expense of the High Plateau since the Low Peneplain came into being.

The CHAIRMAN: I am quite innocent in regard to plateaus and peneplains; nevertheless I have listened with great interest to the paper. I think, Dr. Brown, the best compliment and the best thanks you can have can be seen in this audience because you have kept it here until ten minutes past seven. On behalf of all present, Dr. Brown, I offer you thanks for your paper in which you certainly have covered a very wide area.

AL UMCHAIMIN, A CRATER OF POSSIBLE METEORITIC ORIGIN IN WESTERN 'IRAQ

RICHARD MERRIAM AND JAMES G. HOLWERDA

AL UMCHAIMIN crater lies in western 'Iraq 90 kilometres west-south-west from Rutba and 30 kilometres south of the nearest point on the Beirut–Baghdad road (see map). Its existence has long been known but until recently it has not been subjected to scientific study. The location is on the Al Hamad Plain or physiographic province. The approximate elevation is 2800 feet and the climate arid (119 millimetres annual precipitation). Maximum relief, excluding the immediate vicinity of the crater, is measurable in a few metres and is generally less. The plain is typically featureless except for the channel of Wadi al Walej and its tributaries. Even in this case the maximum relief does not exceed about 20 metres, and this occurs more than 50 kilometres north of the crater. Drainage, except that in the crater itself, is along broad, very shallow, wadis of random, more or less dendritic, pattern. In places the wadi courses are difficult to distinguish, even on the ground. Although good topographic control is lacking, the terrain adjacent to Al Umchaimin seems to be slightly higher than the surrounding terrain. Except for short, steep draws that have cut into the crater rim a fraction of a kilometre, all drainage is away from the crater and joins the roughly concentric surrounding pattern of Wadi al Walej. The entire area is underlain by essentially horizontal Eocene limestone. The rocks are well-bedded with individual strata averaging 1 to 2 metres in thickness. The upper portion of the section contains abundant nummulites and chert nodules. The latter, through residual accumulation by weathering, have formed large areas of desert pavement on Al Hamad plain. The weathered chert fragments are typically coated with manganese dioxide. The whole region is free from faulting. A regional northward dip of 1 degree or less is locally imperceptible but known from regional studies. There is no deviation from this near horizontality at the crater.



Al Umchaimin contrasts strongly with surrounding physiography. Along three-fourths of its 10-kilometre circumference there are cliffs of exposed rocks and steep talus slopes. Where these are absent erosion appears to have smoothed the ruggedness locally. The south (higher) rim is approximately 35 metres above the crater floor and the north rim rises 25 metres. Descending into the crater one first crosses the rugged outcrops of horizontal limestone beds forming steps or small 1 to 2-metre cliffs totalling 10 to 15 metres. Below this is a somewhat less rugged slope of rubble and interstitial soil which, over a vertical distance of 15 to 20 metres, gradually changes to a less steep slope of coalescing alluvial fans. In the deeper drainage lines this interval

is represented by more or less continuous exposures of limestone and marly limestone. Drainage on the alluvial slope is chiefly radial but portions exhibit a peculiar rhomboid pattern produced by the intersection of numerous drainage lines. The fans extend approximately three-fourths of a kilometre to the central playa-like floor which is composed of calcareous clay. During much of the year the floor is at least partly covered with water less than 1 metre deep. It is not perfectly flat as shown by the uneven accumulation of water along one side at the time of this study. Wind action may be the cause of this. The dry portion exhibits extensive mud cracks. In plan view the crater is nearly circular or slightly elliptical with a diameter of 3·2 kilometres. Minor irregularities are present and apparently due to erosion by streams draining into the depression. The sub-circular central playa is somewhat more than 1 kilometre across.

In determining the origin of this crater, the various processes known to produce depressions have been considered; but in the following discussion only the most feasible ones are included, along with evidence for and against.

Solution.—A number of solution sinks occur in the desert of western 'Iraq, although none are within 200 kilometres of Al Umchaimin. All are much smaller and with one exception are irregular in shape. Furthermore, all other known sink-holes in the desert region of western 'Iraq are associated with a characteristic residual-conglomerate, well cemented, reddish brown in colour, and containing a high percentage of chert, heamatite and silicified Eocene shells. No such residual conglomerate was noted at Al Umchaimin. In more humid countries many sinks, as in karst topography, are circular and large, although to the writers' knowledge none approach the dimensions of this crater. The presence of such a limited area draining into Al Umchaimin is not compatible with origin by solution. Only the terrain immediately adjacent drains inward while all major, regional, drainage lines bypass it. For the solution of such a large volume of limestone a great quantity of water would be required; more, it would seem, than could be supplied by the meagre precipitation in so small an area. If solution had occurred there should be a great quantity of residual chert nodules. Even from the relatively slow weathering around the crater the ground is covered with them but in the crater few are seen. Solution of a salt dome which has reached the surface is ruled out on the basis that none of the formations are known to contain salt and deformation of strata resulting from salt dome movements is absent.

Wind erosion.—This process has been used to explain other large depressions in 'Iraq, most notable being the Tharthar depression (Hitchen, 1948). However, it is difficult to see how formations such as limestone and chert which are resistant to wind abrasion could be excavated by winds. Furthermore, wind would not produce a circular depression and there are no Aeolian deposits in the vicinity.

Volcanic.—There are no igneous rocks at Al Umchaimin or within a radius of at least 100 kilometres horizontally. East and south-east of Damascus are numerous aligned cones and associated flows but there is no reason to believe them to be related to this crater. Although many crypto-volcanic structures are this size and shape their formation always results in highly deformed and faulted rocks. Such structures are entirely lacking in the case at hand.

Meteoritic impact.—Craters which in many respects resemble this one are known to have been formed by this process. Positive evidence of such origin is lacking, although there may be good reasons why such evidence should be missing. The chief resemblance to known meteoritic craters is the shape, *i.e.* its circular to slightly elliptical plan. In addition, one rim (south), is somewhat higher than the opposite rim, a common situation in most meteoritic craters. The diameter of Al Umchaimin is nearly three times that of the largest authenticated meteoritic crater (Arizona Meteor Crater). It is somewhat smaller than the controversial New Quebec Crater. The ratio of depth to diameter is considerably less than in the Arizona example. It seems likely that erosion of the rim and deposition in the crater has greatly changed the ratio in Al Umchaimin. The lack of meteorites is a major objection to acceptance

Vertical air photograph of Al Umchaimin depression: the crater is approximately 3.2 kilometres across

of this theory of origin. However, in this connection it should be pointed out that in this brief study two men spent less than two hours without equipment of any kind in the search. The chance of finding meteorites visually is greatly reduced by the fact that most of the ground surrounding the crater is almost completely covered with dark-brown to black, irregular-shaped and pitted chert fragments bearing a striking resemblance to meteorites.

No geophysical survey was made but it was determined that there is no magnetic anomaly detectible with a Brunton compass. The absence of meteorites, upturned crater edges, and fused or brecciated rocks might be explained if it be assumed that the crater is very old, at least pre-Pleistocene. During that time erosion and weathering could have removed this evidence so that all that is seen today are the products of the normal geologic processes of erosion and deposition. In conclusion, the writers believe meteoritic impact, with subsequent modification by surface processes, to be the most likely mode of origin although it is readily admitted to be far from proven and Al Umchaimin should not yet be considered an authenticated meteoritic crater.

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FROM THE *JOURNAL* A HUNDRED YEARS AGO

THE FOLLOWING abstract is taken from the account of the Presentation of the Royal Awards for 1857: *Journal of the Royal Geographical Society*, Vol. 27, pp. lxxxix–xciii. The Patron's Medal was awarded to Lieutenant-Colonel A. S. Waugh "for his valuable and able extensions of the Great Trigonometrical Survey of India" and for "having determined that of all the mountains whence the affluents of the Ganges run, the loftiest summit is situated about midway along the Himalayan chain, and finding that this culminating point . . . was 29,002 English feet above the sea, and consequently 846 feet loftier than the famous Kinchinjanga of Nipal, Colonel Waugh has gratefully and appropriately named this, the highest known elevation in the world, Mount Everest, after his valued geographical instructor." In receiving the medal on behalf of Colonel Waugh, Colonel Everest said:

". . . The applause of our fellow men is naturally prized by us all and nothing is more cheering to a person engaged in an arduous undertaking, replete with privations and hardships, than the persuasion that, if he endures to the end, his labours will not be unrequited. Colonel Waugh, however, is not of that stamp to need such a motive to induce him to persevere in the strict performance of his duty, and having no precedent which could hold out the prospect of such a distinction as the present, it will come on him altogether as an unexpected boon, and as such, will be additionally acceptable. . . .

. . . The Trigonometrical Survey of India has been in progress ever since 1803, a period of 54 years, and will, in its entirety, embrace a tract which exceeds the area of Great Britain and Ireland in the ratio of about 12½ to 1. Of course a vast deal still remains to be accomplished before so gigantic an undertaking can be pronounced complete; and as Colonel Waugh has now been engaged in this arduous task for 25 years, it is needless to expect much prospective effect from the present award as far as he is concerned, for his career in India must be drawing towards its close; but the memory of the present graceful act of this Society will assuredly not be lost on his eventual successor, or on India in general. He is still in the prime of life; and though he has suffered lately from more than one severe attack of illness, yet it is to be hoped that the injury which his constitution may have thereby sustained, is not greater than can be restored by a return to his native country, and that he will some day arrive to return his thanks in person to the Royal Geographical Society, and by his co-operation and counsel add fresh vigour to the active exertions of a body so effective—the first—the only learned Society in England, let me say, which has ever held out the hand of sympathy, friendship, and encouragement to the Great Trigonometrical Survey of India. . . ."

THE FRENCH SCHOOL OF GEOGRAPHY

LA GÉOGRAPHIE FRANÇAISE AU MILIEU DU XXe SIÈCLE. Edited by G. CHABOT, R. CLOZIER and Mme. J. BEAUJEU-GARNIER. *Paris: L'Information Géographique et J-B. Baillière et Fils*, 1957. $6\frac{1}{4} \times 9\frac{1}{2}$ *inches;* 333 *pages*

NOW THAT ONE half-century of scientific geography has elapsed, it is well to examine achievements, present trends and future prospects. The renaissance of geography owes much to the French, especially to Paul Vidal de la Blache. It was in 1915, just before his death, that Emmanuel de Martonne presented a first report on French geography to the San Francisco International Geographical Congress. Now, so shortly after the passing of de Martonne, to whom our generation of geographers owes so much for putting the "Ge" firmly into Geography, comes this comprehensive survey prepared for the Rio de Janeiro Congress. It is the work of thirty-eight contributors who have written forty-two essays—some largely bibliographical, some essentially philosophical. Two discuss the whole character, tendencies and organization of French geography, thirteen analyse French contributions to physical geography, eight review aspects of human geography, eleven examine French writings on continents or large countries, and the rest deal with applied geography, research facilities and resources, journals, cartography and the international bibliographies. Thus the scope is wide, and the editors are to be warmly congratulated on assembling such a valuable collection of analyses. They and the publishers even succeeded in publishing in mid-1956 a book dated 1957. How refreshing it would be if British publishers could emulate this!

Professor Sorre and most of the senior contributors remind us that it was the comprehensive regional study that typified the French School and brought it fame. Many find sadness in the present paucity of such studies; others find continuing virility and distinction in the modern very specialized regional studies and in the many new aspects now being developed. Professor Cholley seems satisfied that French geography still unifies physical and human geography, though many here will challenge his statement (p. 14) that this is less true of Anglo-Saxon geographers. Indeed, geography in its undivided glory may be studied equally in the Faculties of Arts, Science and Economics in most British universities, and that has never been possible in France.

Professor Baulig reviews the progress of geomorphology in France up to 1940, and Professor Jacqueline Beaujeu-Garnier describes the modern approach—the taking of field specimens into the laboratory, and their analysis and measurement therein to explain earth processes. Important work has been done on the decomposition of rocks and in climatic morphology, as the vast output on periglacial morphology has shown. Capot-Rey, writing on desert morphology, considers wind and the effects of humidity and frost as more important than mechanical erosion. The most resistant rocks are those that are the most impervious. Valleys and slopes were most developed not in the wettest or driest periods but in transitional ones. Tricart discusses glacial and periglacial geomorphology, stressing the preponderant part played by Quaternary periglacial phenomena in the evolution of the French landscape. Derruau gives details of recent work in volcanic morphology, especially in the explanation of forms through the study of magmas, new classifications of volcanic conglomerates and of volcanoes, and the processes of their erosion. Blanc reviews three main lines of research in karstic morphology: underground hydrology and morphology, the effects of different and alternating climates, and the great consequences to karstic regions in the Causses and in southern Ireland of a warm damp climate at the end of the Pliocene. On the other hand, a cold period arrested karst development.

Veyret notes the present separation of research into wholly physical or wholly

human aspects of mountain geography. Describing studies of the pre-Alpine furrow and of the Limousin, he suggests that controversy has been mainly upon the relative parts of erosion and of the now more favoured factor of structure in explaining land forms. As between the work of water and of ice, most now favour the latter. On the human side, there have been many studies of population, of elections, and of power and industry.

Guilcher, so well known to us for his work in the British Isles, characterizes research of a few workers in coastal morphology as being directed mainly to contemporary processes and forms. He gracefully acknowledges the lead of Steers, Lewis, Schou, Nielsen and Hansen, and describes work on the Gironde, Loire, Senegal and French Guinea river estuaries; and on spits, taking account of dominant local winds, maximum fetch in narrower seas, and of swell in wider oceans. Research has also been directed to chemical, physio-chemical and to biological factors in coastal erosion; to coral reefs and beaches. Guilcher also contributes a chapter on oceanography, and contributions by Péguy on climatology, Gachon on pedology, Birot on plant geography and Pardé on fluvial hydrology complete the chapters on the more purely physical aspects.

Beaujeu-Garnier and George are the outstanding French pioneers in population geography. The latter has developed a means of calculating optimum or economic densities, and both are making, or have made, regional and general studies of population. Perpillou reports on political, social, economic and technical explanations of nucleated rural settlements, while increased freedom and technical efficiency are factors which have promoted dispersion. Rarely is one type found exclusively, both have ebbed and flowed in time. Chabot explains recent efforts to define and systematize urban geography. New prospects have been opened up by studies of town-districts, individual roads, bus routes, railway stations, the distribution of markets and cinemas, and of town-country relationships.

Champier suggests that the word "geopolitics" should be retained to mean, as in the original definition of Kjelen, "the science of the State as a geographical organism, of the State in Space," and that political geography would then be the study of all other incidences of politics on geography. Not only would this further divide a branch of human geography but it would seem to exclude the study of the influence of geographical factors on policies.

Historical studies are to the fore in agricultural geography, while in industrial geography most published work has been either on all industries in a region, on one industry nationally, on the characteristics of an industrial region, or on the subject as a whole, *e.g.* P. George, 'Géographie industrielle du monde.' General studies in transport geography have been made by Capot-Rey, Sorre and Journaux, whilst other studies have been devoted to roads, railways and ports.

Dion, in a short contribution, describes his teaching of historical geography at the Collège de France as "retrospective human geography" which, starting from the beginning of the Railway Era, pushes its researches sufficiently far into the past to explain those varied forms of man's work which are still to be seen on the land. It is this latter point which, according to Dion, distinguishes the historical geographer from the historian. Nevertheless, Dion insists upon the vital rôle of history in shielding us from determinism. Why, he asks, are the vine and olive regarded as indicators of Mediterranean climate and vegetation, when in fact they were spread by Greek colonization and Roman conquest?

As elsewhere, French geographers and their professional bodies are taking an increasing part in planning. Some, like Blanchard, seek further recognition; others, like Sorre, feel that scientists should pursue science alone; others, with Le Lannou, take a middle course. Giraudoux regards a geographer as an "ensemblier," and Chabot has compared his function with that of a general medical practitioner who coordinates the work of specialists.

Those of us who have studied and lectured in French universities in past years will

recall that equipment was often mediocre. It is good, therefore, to read of the generous grants now given by the Centre National de la Recherche Scientifique to departments for the purchase of research equipment, to teachers and students undertaking research in France and abroad, to journals and publications (such as this volume under review), to professional meetings, to libraries and to map and photographic collections. French geographers are now quite handsomely subsidized at home and on missions abroad.

Here then is another geographical stock-taking akin to 'American geography: inventory and prospect.' Comparison of the contents of these volumes reveals the weaknesses of French geographers in their scientific and economic training, and so in their low output in climatology, in true economic geography, in medical geography, in the teaching of air photo interpretation and in cartographical techniques. But in the other great fields they retain their vigour and strength. Why is this, and what lessons have the French to teach us all? They are the importance of their intensive literary and historical training, of their devotion to the regional method and to minute field work, and of their competence in both physical and human aspects, as well as in general geography. Like the American volume, these forty-two essays provide a most useful bibliography as well as an examination of a brilliant school.

R. J. HARRISON CHURCH

HILL-SHADING IN THE NEW QUARTER-INCH ORDNANCE SURVEY MAP

QUARTER-INCH FIFTH SERIES MAP: Sheet 10, North Wales and Lancashire. *Chessington: Ordnance Survey*, 1957. 1:250,000; 25½×31½ *inches; 3s paper flat; 5s paper folded; 7s linen mounted, folded in covers*

THE FIRST sheet of a new map series—the Quarter-Inch Fifth Series, Sheet 10—was published by the Ordnance Survey in May. The sheet covers North Wales and Lancashire, and it is planned to publish the remaining sheets covering Great Britain during the next five years to replace completely the present Fourth Edition.

In its design, the map differs from the Fourth Edition in many respects. To conform with continental practice and the requirements of air navigation, the scale has been altered from 1/253,440, or one quarter-inch to one mile, to the scale of 1/250,000; but, as the change is slight and will not be apparent to the general user, the more convenient title of "Quarter-Inch" Map is being retained for the present. Again, the amount of detail shown has been greatly reduced when compared with the Fourth Edition, in the knowledge that for more detailed reference there will exist an up-to-date One-Inch Map and within a few years a new Half-Inch Map. And thirdly, the method of depicting the relief of the ground has been altered. Hypsometrical or layer tints have been retained, but, as these layer tints change at the same interval as the contour interval, the experiment of omitting the contour lines is again being tried, as was done in the "Ten Mile" Topographical Map, with the object of lightening the appearance of the map without taking away any of its value, while hill-shading has been added to give a more readable picture of the relief of the ground, which should help the less expert map reader.

"Hill-shading" can be defined as the addition of shadows to give the optical illusion of a third dimension, making hills stand out in relief. The shadows can be regarded as those which would be cast on an imaginary relief model of the ground when illuminated by parallel rays of light from a selected direction or directions. In this map, the light is assumed to be from the north-west at an angle of 45° with the horizon.

The use of hill-shading in maps is fashionable at the present time, particularly on the continent, but although modern techniques may be new, the ability to show the relief of the ground by hill-shading has long been appreciated, and was practised both in England and in France over one hundred years ago. In England, at the beginning of the nineteenth century, a specialized form of hill-shading called "hill-sketching" was used by the field surveyors of the Ordnance Survey in the preparation of the field sheets of the first One-Inch Map. From the hill sketch, the hill drawing was made in the drawing office to act as a guide for the engraving on the copper plate of the hachures, *i.e.* the shading lines drawn in the direction of the slope at each point. The original field sheets of this first survey have recently been presented by the Ordnance Survey to the British Museum, where they are available for reference. They cover nearly the whole of England and Wales up to the line joining Hull and Preston, and were surveyed between 1784 and 1842.

The method adopted for hill-sketching in the earlier field sheets completed was to shade the ground in proportion to the slope of that ground, the shading lines being horizontal lines at right angles to the line of slope, and hence at right angles to the hachures which were finally engraved on the copper plate. At first the hill-sketching was crude and heavy, but under Robert Dawson's influence the technique was improved and the later field sheets produced were finely drawn, and showed much artistic ability in the depiction of the hills. Robert Dawson (1776–1860) joined the Ordnance Survey in 1794. His approach to his work was essentially artistic. On the occasion of the appointment of a Committee on Contouring in 1854 under the Earl of Ellesmere, he gave his opinion in the following words on what he thought a topographical map should be: "By a topographical map then I should understand the full face pictural representation of a place, district, or country in its natural figuration of mountain, hill, valley and plain, the whole harmoniously in one pictural exhibition to the eye. . . . Drawing in its application to maps or plan drawing is not confined to delineation only, but to the whole expression of form in respect of ground." So wrote Robert Dawson. He was indeed a draughtsman with a highly developed artistic sense, and the Ordnance Survey was fortunate in having his services at its foundation.

About the same time as the first One-Inch Map was being produced by the Ordnance Survey, Louis Puissant published in France in 1820 his treatise 'Traité de topographie, d'arpentage et de nivellement,' in which he discussed at length the depiction of relief in topography, and advocated the use of hill-shading. The following extract from his treatise summarizes his views. "For topographical maps on a small scale as distinct from cadastral plans, the map reader only needs to grasp certain ground forms as part of a general picture of the terrain, without having to read continuously and with difficulty the spot heights and lines of greatest slope. A quick and easy method is required to show the relief of the ground to the eye at once. Nature herself gives us the method. It consists in imagining that the surface of the earth is illuminated by a pencil of rays inclined at an oblique angle to the horizon. From the resulting contrasts of light and shade we are given a vivid perception of the shape of the ground. It is enough to know a few conventions in topography and a little about the theory of shadows to read with the greatest of ease a map drawn according to the French way." There was one essential difference between the English hill sketch and the French method described by Puissant. In England, the shading denoted the varying intensities of the reflected light from the ground when illuminated by vertical rays of light. In France, the shading denoted the shadows cast by rays of light inclined at an oblique angle to the horizon.

A study of the past editions of the maps of the Ordnance Survey will show that, in spite of the introduction of contours about 1850, the Ordnance Survey continued to use in its topographical maps some additional method to assist in the depiction of relief. This policy was in keeping with the recommendation of the Treasury Committee of 1854 under Lord Ellesmere, which "had in view hill-sketching on the ground and hill-drawing on artistic principles to which they proposed should be added selected

contours." Consider the One-Inch Map: the First Edition or Old Series and the Second Edition or New Series were both hachured. In the Third Edition in the large sheet form, begun in 1892 and completed in 1912, contours were printed in red over light brown hachures. For reasons of economy, the hachures were omitted from the Fourth or Popular Edition published after the 1914–18 war, but this omission was not very acceptable to the average map user, and it resulted in the publication of a layered or shaded map of selected tourist areas, and later influenced the decision to start the Fifth Relief Edition. In the Fifth Relief Edition, those portions of the hachures which fell on the shadow side of the hills were overprinted in violet. Due to the Second World War, the Fifth Relief Edition was never completed, and after the war the Sixth Edition (the New Popular) was hurriedly produced as a provisional edition pending the publication of the redrawn and revised Seventh Series. In the Sixth Edition, the relief of the ground was indicated by contours only. The position today is not dissimilar from the period after the 1914–18 war except that the hachure plates are no longer available. The present Seventh Series is published with contours only, and hill-shaded tourist maps of selected areas are being published.

The story of the Quarter-Inch Map is similar. In the First Edition begun in 1859, the hills were shown by hill-shading derived from the hachures of the One-Inch Map. The second edition in a similar style was begun in 1912 but was never completed, being interrupted by World War I. In 1919, the first sheets of the Third Edition were published, in which hypsometrical or layer tints were added to the contours to depict relief, but hill-shading was omitted. The Fourth Edition begun in 1923 was similar in style to the Third Edition.

In the new Quarter-Inch Fifth Series, layer tints have been retained, contour lines omitted, and hill-shading has been added. Since a contour plate is made for the purpose of preparing the layer tints, it is quite easy to print an edition in which the contour lines are added, should this be required to serve public or military needs or the needs of air navigation. It should be noted that, except in very small-scale maps normally seen in atlases, the combination of layer tints with hill-shading is rare, the more usual method being to combine hill-shading with contours only. There is some difficulty in combining layer tints with a shadow tint. The shadow tint may be suitable on one layer tint but be quite unsuitable on another layer. The choice of the right colours for the layer tints and for the shadow tints demands great care. Hillshading is also being introduced into the new One-inch Tourist Map of the Peak District which is due to be published in July, 1957.

It may therefore be concluded that by introducing hill-shading into the new Quarter-Inch Fifth Series, the Ordnance Survey has merely followed a traditional policy. In doing so in this series, the aim has been to produce a map suitable for motorists and giving a picture of the ground which is not only easy to read, but is also, to use Robert Dawson's phrase, a "harmonious whole, pleasing to the eye," and it is hoped that the Quarter-Inch Fifth Series will in some respects achieve this aim. LOUIS HARRIS

REVIEWS

EUROPE

WESTERN EUROPE. By E. D. LABORDE. *London: University of London Press*, 1955. 8½×5½ *inches;* xii+284 *pages; maps and illustrations.* 17*s* 6*d*

There has undoubtedly been a need for an up-to-date book on Western Europe at the intermediate level, and Dr. Laborde has gone far towards filling the gap. Western Europe is, as he points out, difficult to define. He has included Scandinavia, but not Finland; Germany, without Austria; as well as Italy and the Iberian Peninsula. The British Isles are covered by the opening "general survey," but are accorded no separate regional treatment. The arrangement of the regional chapters follows the orthodox pattern: structure and relief are followed by climate and vegetation, and by regional divisions and economic development. The balance between these sections is well maintained, and the book as a whole is tidy and workmanlike. It is illustrated with a large number of photographs of exceptional quality. Many are aerial photographs and are a welcome change from the general run of text-book illustrations. It is also graced with many sketch-maps, not all of them particularly informative, but very clearly drawn. The book has a number of blemishes which could have been obviated by a more careful proof-reading. There are also several errors, such as the suggestion that Saar coal is of great significance to the French metallurgical industry. A map of "race" in Western Europe is unduly simplified, and the author shows lines which purport to show the "northern limit of Roman Catholicism" and the "western limit of the Greek Church," as if these had the precision of the limits of glaciation or of olive cultivation.

N. J. G. POUNDS

SEEING ROMAN BRITAIN. By LEONARD COTTRELL. *London: Evans*, 1956. 9×6 *inches;* 280 *pages; sketch-maps and photographs.* 21*s*

One is tempted to wonder whether Mr. Cottrell's "rubber-neck" guide book to the Roman antiquities of Britain was really necessary. His previous attempts to provide potted archaeological knowledge for the public—*e.g.* 'The Bull of Minos'—have been more successful, perhaps because he was content to present his subject in broader outline. Here, in a breathless description of a 3500-mile drive round Roman Britain, he has tried to produce a Baedeker, but has completely failed. The first essential in a Baedeker is accuracy, which in this book is conspicuously lacking. Neither author nor publisher have taken any trouble as regards proof-reading, so that almost every page bristles with mis-spelt place and proper names. Thus the Emperor Antoninus Pius is hardly recognizable as "Antonius Pilus" (p. 228), and Domitian occurs twice on p. 203 as "Domitius." The errors in place-names are still more glaring: on p. 105 the Roman name of Durovernum (really Canterbury) is ascribed to Dorchester, while on p. 165 Cambridge (probably Durolipons) is alleged to be "Camboritum," and Godmanchester (probably Durovigutum) is called "Durolipone." Well-known sites such as Carrawburgh and Housesteads are mis-spelt throughout. Mr. Cottrell displays unnecessarily his ignorance of Latin grammar and genders by garnishing his text with expressions like "rex britonnorum" (pp. 51 and 52) and "litus Saxonicus" (p. 33). The scholar will avoid this book and the tourist is warned against it.

J. H. MARSHALL-CORNWALL

REPORT ON REGIONAL PLANNING IN BRITAIN, THE NETHERLANDS AND GERMANY. By T. J. D. FAIR. Reprinted from *Commerce and Industry*, May 1956. *The Government Printer, Pretoria*, 1956. 9×7 *inches;* 28 *pages*

The planning of the "Controlled Areas" and the implications of present economic policies have augmented the importance of regional planning in the Union of South

Africa. Prepared by a Planning Officer of the Natural Resources Development Council (a body responsible for regional planning within South Africa), this Report is concise and factual, and in a few pages provides a summary of the organization, method and scope of regional and development planning by various authorities in Britain, the Netherlands and Germany.

Much of this outline is familiar, although it is interesting to note that planning research in the Netherlands and Germany is undertaken by permanent organizations sponsored by the government which cooperate with universities, colleges and technical institutes and freely make available the results of their research. Here is apparent a contrast with Britain where much research is in the hands of inter-departmental committees of the Ministry. More controversial is the last section of this report, entitled "Some conclusions and general observations." In this section attention is drawn to the principle of decentralization of local government in Europe and the restrictive influence of this system on regional planning where a large number of local authorities are concerned. Mention is also made of the differing popularity of the planning services in these countries, and of the applicability of the unique planning requirements of each of these countries to the present situation in South Africa.

H. THURSTON

LAND AND LABOUR IN EUROPE, 1900–1950. By F. DOVRING. Edited by G. Berger and J. Isaac. *The Hague: Martinus Nijhoff*, 1956. (*London agent, B. T. Batsford.*) 10×6 *inches;* iii+480 *pages; map*

This is the age of the mathematical economist and the trained statistician. We should therefore suppress flippant instincts when encountering a passage such as the following in an agrarian study: "On such a plain, village territories may be laid out as squares, as envisaged in planning the new Dutch polders. The distance from one village to another would then be equal to the side of the square. The shortest distance from the village centre to peripheral land would then vary between half the side of the square (that is to the mid-point of the side of the square) up to 1·415 times as much:

$$\sqrt{(2.\tfrac{1}{2}S)^2}=\sqrt{2}.\frac{S}{2}=1{\cdot}415.\frac{S}{2}."$$

Perhaps we shall one day be shown this remarkable formula in terms of dyke and polder, crop and farm, road and canal? Perhaps it would be plain rudeness to suggest that this is often an agrarian study of Cloud Cuckoo Land with an infinity of nice, square polders on which the statistician can exercise his ingenuity.

Much of the difficulty lies in the blurred English of the book. The authors have a command of a language not their own which many English scholars might envy, but it is not enough to elucidate an abstruse approach to agrarian structures, nor to convince the reader of its practical value. This shortcoming is plainest in the chapter on "Land policy," where a more conventional treatment of agrarian reform bears no comparison with a good deal of competent written work already extant and widely accepted. Mr. Dovring writes that agrarian history is neglected by professional historians, and of course such literature is patchy, especially that concerning the last fifty years. But there is a good deal of published work showing admirable historical sense and first-hand knowledge of the areas chosen for study. The books of Foerster, Maynard, Lamartine Yates and Warriner come to mind and the excellent inter-war compilation of the Royal Institute of International Affairs.[1] Any of these would bring more conviction to the reader than successions of tables listing "weighted" farm structures, "man-land" units, "man-years" available and "cow"-units. The authors have plainly studied and reflected so profoundly on their themes that so amorphous

[1] Foerster, R., 'Italian emigration of our time.' Maynard, J., 'The Russian peasant.' Lamartine Yates, P., 'Food production in Western Europe.' Warriner, D., 'The economics of peasant farming.' Royal Institute of International Affairs, 'World agriculture.'

a result is a great pity. Something useful should emerge from so much learning, but Mr. and Mrs. Dovring seem to have travelled the length and breadth of Europe with a huge calculating machine between them and the landscape. HARRIET STEERS

RUSSIA IN PICTURES. Introduction by A. FICHELLE: translated by Laetitia Gifford. *London: Duckworth*, 1956. 10×7 *inches;* 112 *pages.* 106 *plates.* 25*s*

DEUTSCHLAND. Introduction by P. FECHTERS, captions by W. LENZ. *Gütersloh (Westphalia): C. Bertelsmann*, 1956. 10×9 *inches;* 240 *pages;* 222 *plates*

TUSCANY. Photographs by Arnold von Borsig, introduction and notes by R. Bianchi-Bandinelli. *London: Thames and Hudson*, 1955. 246 *pages;* 200 *plates.* 50*s*

PROVENCE. By M. BRION, translated by S. G. Colverson. *London: Nicholas Kaye*, 1956. 9×6½ *inches;* 247 *pages;* 180 *illustrations.* 30*s*

As with anthologies, individual preference is hard to satisfy in picture-books of this kind, however good they may be; and it is no easy task to present a whole country in a single volume. The least successful here is, not surprisingly, the book which sets out to cover the largest area. 'Russia in Pictures,' at 25*s*, is not for my money. The professor at the School of Oriental Languages in Paris, whose translated preface and notes fill the first sixteen pages, has done what he can to put a little life into a very dull book appropriately bound in drab homespun. The plates are in fuzzy photogravure of a greenish colour. Those of potential interest lose everything by the bad quality of reproduction, and the many null and void are made the more irritating by their bilingual captions, of which "Traineau . . . Sledge" is a fair example. To reduce one-sixth of the world's land surface to 178 plates needs rather more imagination than is shown here.

'Deutschland' is much better value. The twelve colour plates are perhaps a mistake, as tending to spoil the eye for the excellent black-and-white; and it is a pity that the only interior view is of the Bordesholmer Altar in St. Peter's, Schleswig: the sort of subject least suited to a single long-distance shot. Marburg, with its unrivalled photographic art library, is near enough to Gütersloh to have been drawn upon for material of this kind. The plates are arranged topographically in a circular tour from south-west to south-east and are preceded by a map, index and full notes in German and French. One's belief in Teutonic thoroughness is rather shaken by a series of discrepancies between the numbering of the notes and of the corresponding plates; but apart from this the text is useful and informative.

Of the four books, 'Tuscany' is the most deliberately an "art publication." Each of its large-scale glossy photographs, the work of A. von Borsig, is a study of unexceptionable quality. Perhaps it is surprising that the earliest Florentine master, Cimabue, has been passed over and that the Medicis are represented by the death-mask of Lorenzo, though it was under the Grand Duke Cosimo that modern Tuscany was first constituted; otherwise the editors have shown great selective skill. Goudy Bold monotype on fine quality paper and covers of terra cotta cloth stamped in gold contribute to a very handsome publication.

Marcel Brion's 'Provence' is probably the most successful of the four in catching the quality of its subject. It is certainly the most engaging. There is a good deal more text here: six chapters sharing the pages with the pictures, which are of all shapes and sizes. The arrangement is less haphazard than at first appears, for the illustrations are placed reasonably near to their context. Though on matt paper, the reproduction is sharp and clear and the subjects chosen with the liveliest taste and originality. From chill Montmajour to the charming little clay santons, all the beauties and complexities of this romantic region have been captured in a most attractive book.

G. LANGDON

SALZBURG ATLAS. Bundesland Salzburg in 66 Kartenblättern. Edited by EGON LENDL in cooperation with WALTER PFITZNER and KURT WILLVONSEDER. *Salzburg: Otto Müller Verlag*, 1955. $14^{1}/_{2} \times 14$ *inches. Part 1: Maps: 4 pages; 66 sheets of maps with 138 single maps and graphs. Part 2: Text: 134 pages with 46 tables and 15 maps and diagrams in the text.* 650 *Austrian schillings, or £9, or 25$*

Austria has a certain tradition in the cartographic representation of the various features of her country, *e.g.* the Physical-Statistical Atlas of Austria-Hungary by J. Chavanne and others, dating back to 1887. After the First World War the new Republic of Austria, much reduced in area as compared to the former Monarchy, focused her attention on her old and well defined provinces. The small Atlas of Carinthia by V. Paschinger, 1925, and the much larger and more modern Burgenland Atlas by F. Bodo and H. Hassinger, 1941, were published, and work on other provincial atlases was started. Structural changes in many parts of Austria, especially in population and economy, during and since the end of the Second World War, made it necessary to examine past efforts and to lay scientific foundations for future planning. Thus, regional atlas work has begun again in Lower Austria (by E. Arnberger), Carinthia (V. Paschinger), Styria (S. Morawetz), Salzburg (E. Lendl), and Upper Austria (F. Pfeffer and H. Maurer).

The Austrian provincial atlases vary considerably, as a result not only of the individual methods of their editors, but of the great variations between the culture and historical origins of the different provinces. Such differences are bound to persist, but to a certain degree they all follow the pattern of the Burgenland Atlas, and have much in common as to contents, representation, and scales.

The first of these atlases to be finished is the Salzburg Atlas. The geographer Dr. Egon Lendl, the artist Walter Pfitzner, Professor Dr. Kurt Willvonseder, and thirty-nine associate authors, assisted by other experts, by federal, provincial and municipal authorities, and by power, industrial and business companies, and sponsored by the Provincial Government and the governor Dr. Josef Klaus himself, achieved their work in about five years between 1950 and 1955.

As to the contents of the Salzburg Atlas, its 138 single maps and graphs and 134 pages of text (including 15 additional maps and diagrams and 46 tables) represent all the important structural elements of the province. About a quarter of its size is devoted to natural features: location, topography, elevations, geology, petrography, hydrography, land forms, climate soils, vegetation, caves, typical regions, and regional divisions. The maps on population show age groups, dialects, types of settlements and farmsteads, field patterns, and occupations. The largest section, about one-third of the atlas, covers the field of economy: land utilization, density of agrarian population, systems of cultivation, cereal culture, forestry, livestock raising on alpine pastures, livestock, dairying, professions, banking, mineral resources, manufacturing industry, power supply, traffic (rail and road, density, development, accessibility to tourists), post, telephone and telegraph, and tourist traffic. The next section treats history (prehistory, early history, land occupancy, archbishopric of Salzburg, protestantism, university of Salzburg), history of arts, and folklore. The remainder of the atlas is concerned with culture (archdiocese of Salzburg, schools and education), public welfare (fire brigades, first aid, public health, sport), administration, and the capital itself.

The maps of the Salzburg Atlas, like those of the other Austrian provincial atlases now in the course of publication, are fine examples of modern offset multi-colour printing; they have, as a whole, comparable scales, and use simple symbols. Although various scales running from 1/50,000 to 1/3M are employed, full-page maps are in general on the scale of 1/500,000, and four maps on one page at the scale of 1/1M; they can easily be compared one with another and with maps of the other atlases. The excellent cartography, based on the traditional methods and taking up the means of representation which O. Neurath has developed in his pictorial statistics and maps (1926–34), makes use of simple pictorial symbols and associative colours, readily

understood by the map reader. The text, written by the various contributors, is a running commentary on the maps and graphs and, moreover, a complete regional survey of Salzburg with bibliographies at the end of most chapters.

The Salzburg Atlas is a comprehensive and illustrative source of information, rich in details and at the same time stressing essentials. It is both a convenient source of reference for all who are interested in the present facts and future possibilities of the natural setting, the cultural and economic life, and the administration of the province, and likely to stimulate further cooperation on regional research.

L. G. SCHEIDL

ASIA

RETURN TO THE IRRAWADY. By F. KINGDON-WARD. *London: Andrew Melrose*, 1956. 9¼×6 *inches; 224 pages; indices; illustrations; map.* 25*s*

Though unexplored territory on this side of the Iron Curtain is in short supply Mr. Kingdon-Ward and his intrepid wife can be trusted to hack a path through red tape entanglements and find their way sooner or later to any mountainous country, however remote, which gives hope of containing plants likely to be hardy in English gardens. And their journeys can never be quick dashes into the unknown at the best time of the year, for a collecting botanist must spend a whole year in his area, visiting each part of it twice if possible, first to find and mark the plants in flower and then to gather the seed. For his 1952–53 expedition the author chose the high range running roughly north and south between the two main branches of the upper Irrawady, the Mali Hka and the 'Nmai Hka, hoping that the isolated peaks running up to 12,000 feet might be the refuge of endemic species. And so it proved. The area is not large, but the climate is vile for much of the year, with constant rain and mist, and the terrain bad enough to daunt a far younger man. The very difficulties which made movement slow encouraged examination in that welcome detail so often lacking in the narratives of speedier travellers.

The author is the recognized authority on the botany of the great tangle of mountains which contains the trijunction point of India, China and Burma, and his main interest is naturally in plants, in his hunt for which he infects the reader with all the excitement of the chase. The tracking down of the strange epiphytic lily makes a thrilling story and the two chapters on the rhododendrons of north Burma are a classic. Some fifty species, from giants 50 feet high to heather-like dwarfs, are described group by group and zone by zone, with constant reminders that in country where distance and movement are almost more vertical than horizontal, altitude and aspect are all-important. Collecting is not a matter of chance. Always the author knows what to expect in a given environment. But he has his surprises and one of the greatest was the finding of a conifer (*Podocarpus imbricus*) 1000 miles by air from its nearest previously known habitat in southern Burma. There is nowhere in between where it could possibly grow today and one can only dimly imagine the vast earth movements which separated the habitats untold ages ago.

It was only after endless frustrations—authorities who did not answer letters and trains which did not run—that the author and his wife reached their goal. Once there they found life much as it always has been, with Kachins, Lisus and Marus pursuing their traditional ways. Of the many pen pictures of individuals, those of the two Burmese Forest Rangers stand out. If their country can produce many men like them she will indeed be lucky. The photographs are up to the very high standard one expects from Mr. Kingdon-Ward, who has written a most valuable and interesting book. But will he please take a little more care of himself, for the sake not only of his wife but of his readers too? He must not crock up.

J. P. MILLS

BORNEO PEOPLE. By MALCOLM MACDONALD. *London: Jonathan Cape*, 1957. 9×6 *inches; 376 pages; plates.* 32*s*

Mr. Malcolm Macdonald's book presents fascinating glimpses of primitive Borneo

tribes in their longhouse communities, with their taboos, superstitions and ancient customs, as well as of some of the changes modern contacts have brought. Longhouse festivities feature prominently and are accurately portrayed, while the author captures the friendliness and spontaneity of the Ibans, Kayans and Kenyahs. The first impact of colonial progress on the up-river people and the attitude of the chiefs is lightly touched upon but too swiftly passed over. The author does not accept an opportunity of giving a far more vivid picture of the reactions to Government suggestions for education, new farming methods, representative changes and so on. As High Commissioner Malcolm Macdonald went up-river to discuss changes with the great characters of Iban and Kenyah society—Temonggong Koh, Penghulu Jugah, Temonggong Tama Weng Taja—all of them, as he shows, forceful and intriguing personalities; but he treats the parties and celebrations as the reason for his visits, politics as a sideline. It is a fascinating stage of development when the pagans begin to forsake their ancient taboos and become Christians, to ask for more education and other amenities, while the chiefs doubtfully approach the idea of representative councils which must inevitably lessen their own power, and far more attention might have been paid to this aspect of primitive Borneo. The parties and pagan ceremonies are of great interest but they are not all Borneo, nor are they the sole occupation of a longhouse as one might be led to believe by this book. The author was a V.I.P. and therefore special ceremonies were always laid on for him, which must explain the emphasis they are given.

An insistence on the primitive savagery of the people, which the author seems determined to bring out (hardly a page goes by without phrases such as husky, primitive, naked savages), ignores the many changes and rapid strides forward that have occurred in Sarawak since 1945. Are the Ibans and Kenyahs, primitive and backward people though they may be, so idyllic, savage or simple as the author suggests? Mr. Malcolm Macdonald is at his best describing some of his Iban and Kenyah friends. The portrait of the young Iban girl Segura is charming. Here can be seen the conflict between old and new. She goes from a remote longhouse to a Mission school and returns with a lipstick, a new hair style and different clothes, shy and disdainful of longhouse customs. After much unhappiness family pressure forces her back, at least in part, to their older ways. In this picture we see all the bewilderment that too swift transition may bring. For effect, perhaps, too much stress has been laid on the savagery and, to the loss of the reader, too little on the changes that modern contacts have already brought. To be repeatedly told that for a moment the writer feared for his head, becomes a little tedious. The enjoyment of the book lies in the vivid accounts of longhouse entertainment and the portraits that emerge of native leaders.

GUY ARNOLD

INDIA'S MINERAL WEALTH: A guide to the occurrences and economics of the useful minerals of India, Pakistan and Burma. By J. COGGIN BROWN and A. K. DEY. *Bombay: Oxford University Press (Indian Branch). Third edition*, 1955. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xxiv+761 *pages; maps, diagrams and illustrations.* 50*s*

The third edition of this book, though following in general outline the scheme adopted in earlier editions, incorporates many changes and innovations. The most important of these innovations is the inclusion of a section dealing with soils and water. This section, together with its maps, will be especially welcome to geographers. Each of the remaining chapters of the book has been carefully revised and on the whole the space given to each mineral accurately reflects its general economic importance. The trebling of the space given to precious and semi-precious stones is, however, hard to understand. Coggin Brown's recent articles in *The Gemmologist* may explain, but not justify, this increased interest, for the additional material is almost entirely historical. The authors have done much in their chapter on atomic metals to overcome what appears to have been a Government of India restriction on the free discussion of this important topic. However, the authors seem to have made no use of the information

made public at the Conference on the Peaceful Uses of Atomic Energy or by the Indian Planning Commission in "The Second Five Year Plan."

One of the most pleasing aspects of this new edition is the excellence of its maps. Many are entirely new, some are redrawn, and all are clear and well presented. The reviewer was especially pleased with the soil map, which incidentally provides some interesting contrasts to Professor Spate's map in his recent book on India and Pakistan, and with two maps, at a scale of nearly 7 miles to 1 inch, of the Jharia and Raniganj coalfields. The photographs are by contrast disappointing and were taken from pre-war memoirs of the Geological Survey; even the originals were not noted for their clarity. The book is well documented, with an up-to-date bibliography, and includes a large number of tables and diagrams. It is, however, unfortunate that the statistics do not go beyond 1950; that is, they do not cover even part of the period of the First Five Year Plan. The authors have also included much original information drawn from private individuals and business concerns, material which is usually beyond the reach of workers in this country.

'India's mineral wealth,' by concentrating upon minerals, is able to provide a depth of information which is not possible in a dictionary of raw materials such as 'The wealth of India,' now in the course of publication by the Indian Department of Scientific Research. Indeed, by treating the three republics as separate entities, Coggin Brown and Dey have succeeded in producing what is in effect one of the best accounts of recent economic developments in Indo-Burma. The authors owe their success in this direction to a skilful blending of geology and economics, a blend which fully justifies the use of the word "wealth" in their title.

MARTYN J. WEBB

WHERE THE GODS ARE MOUNTAINS: Three years among the people of the Himalayas. By RENE VON NEBESKY-WOJKOWITZ. *London: Weidenfeld and Nicolson*, 1956. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches; 256 pages; maps and illustrations.* 21*s*

The last few years have seen a number of good travel books on the Nepalese–Tibetan region and this volume is surely one of them. In some ways, it is one of the best because the author went specifically to this of all possible areas: his journey was not dependent on the war or other extraneous circumstance. He previously learned what he could about the religion and the language of the Himalaya, and he was trained in Vienna as an anthropologist. Some of his academic asides, as on the subject of Tibetan books, are the best things he offers. His glimpses into the religious practices and trance states of the lamas are fascinating. The difficulty is that the reader is left hungry for more. Why should authors of "travel books" assume that their potential audience is interested only in the tantalizing? It is true that most professional travellers are incapable of giving more. But here is one who obviously kept a tight rein on his knowledge; it is a book of people yet none are given their full due. Publishers must finally realize that the full-rounded incident is the backbone of the travel book, and that well-chosen detail is its most important feature. Yet we are constantly being skimped in the name of some myth of "readability." But let us not be overcritical in the present instance. This is an unusually good book. Suppose it could have been better? It is still very good and the translation from the original German seems to have been adequately managed.

MARIAN W. SMITH

BYZANTIUM AND ISTANBUL. By ROBERT LIDDELL. *London: Jonathan Cape*, 1956. $9\frac{1}{2} \times 6$ *inches; 256 pages; map; illustrations.* 25*s*

Mr. Liddell, despite a strong antipathy to modern Istanbul, has written a remarkably good book. Its plan is simple and effective. Before the critical chapters dealing with the Byzantine monuments he gives us a fascinating account of the Byzantine Emperors. His analysis of Ottoman architecture is preceded by a history of the Sultans and by a penetrating survey of life in the "Grand Turk's Seraglio." This chapter is not for everyone's maiden aunt, and few holds are barred. These tales,

however, have been told before; it is the more placid chapters, devoted to architecture, that form the real backbone of the book and will give it lasting value. The author disapproves of those Byzantine pedants who cannot enjoy anything built after 1453. Indeed, he seems to prefer (with reservations) Ottoman to Byzantine art in Istanbul, where only the interior of St. Sophia, now a heartless museum, can outshine the calm, prayed-in beauty of the mosque of Süleyman the Magnificent. Mr. Liddell writes about things he really knows. His long acquaintance with Greece and Cairo has equipped him singularly well to assess the architectural merits of old Istanbul. He wears his knowledge lightly, and writes with so precise and polished a style that one is left with nothing but admiration for this discriminating, highly civilized Philhellene. Prejudiced and crotchety he may at times appear, but he wins us over by his integrity. It seems a pity that this well-illustrated book, which could serve as a guide to Istanbul as well as delighting us at home, should contain a most ineffective map of the city. It marks very little, and though the monuments are listed in an appendix, grouped according to the hills on which they stand, we can find few of them—and none of the hills—on the map. P. H. DAVIS

A TURKISH-ENGLISH DICTIONARY (2nd Edition). By H. C. HONY. *Oxford: The Clarendon Press*, 1957. 9¼×6 *inches;* xii+419 *pages.* 35*s*

The second edition of Mr. Hony's admirable dictionary appears ten years after the first, which has been improved by many additions and prunings. It is quite indispensable for any student of modern Turkish and helps him to avoid the numerous pitfalls provided by the somewhat arbitrary romanized alphabet introduced by Mustafa Kemal in 1928. A valuable feature is the inclusion of a number of idiomatic and proverbial phrases under the key-words, while a short appendix records some of the priceless sayings of the immortal Nasreddin Hodja, so frequently alluded to in modern Turkish conversation. J. H. MARSHALL-CORNWALL

TRAVEL IN ASIA

The charm of books of travel is that even when they cover similar parts of the world they can offer the widest possible variety. These two books are excellent examples of their kind. In HANDLES OF CHANCE (*Cape*, 1956, 24*s*), Mr. Wollaston gives a delightful account of his journey from the Solomon Islands to Istanbul with the main focus on India and Persia, while Mr. Mayne describes his search for hereditary saints in Sind (SAINTS OF SIND, *John Murray*, 1956, 18*s*). Both books are light-hearted and give a picture of life as more orthodox travellers rarely see it. Mr. Wollaston covered India from Lahoul to Goa and Pakistan from Peshawar to Quetta. He travelled hard and writes wittily of the less pleasant consequences of this. His descriptions of people and places are full of understanding and appreciation, while he does not neglect the political aspects of the two countries, whether it be the impact of independence on India, the problem of Pakhtoonistan or the attitude of Indians towards the U.S.A. or Britain. His impressions of Isfahan, Persepolis and Sheraz are not affected by the irritations inflicted on him by bureaucracy, when he made his first attempt to cross the frontier into Turkey. Altogether he is the ideal traveller, undeterred by obstacles and inconveniences and unhampered by the limitations of time. His book may be recommended to anyone seeking a brief and happy journey with a companion, who has a deep sympathy with human nature and a keen sense of humour.

SAINTS OF SIND is more limited in its scope, but no less interesting as an account of a strange country with an unusual institution, namely hereditary holy men. Mr. Mayne does not go into the detail of the religious or philosophical background of this system, but confines himself to describing in some detail the shrines, the saints and their followers. He gives special attention to the Pir Pagaro, whose followers were a problem to the British for many years and who was in 1952 restored by the Pakistan Government to the "throne" that had been left vacant in 1943 by the execution of

Pir Sibghatullah. The book is a strange mixture of holy crocodiles, wild dervishes and fantasy, induced by an experiment with "bhang" and one feels that perhaps, after all, the author's final words are also true of the reader as far as this matter is concerned. "Alas, Kaka Sahib, I seem incapable of learning anything." However, this should not deter us and Mr. Mayne's witty book may well lure many to seek more knowledge of this remarkable body of holy men, whose influence affects such a vast number of followers in Pakistan and India.

J. E. F. GUERITZ

AFRICA

SCHEIK IBRAHIM (JOHANN LUDWIG BURCKHARDT). Briefe an Eltern und Geschwister. Edited by C. BURCKHARDT-SARASIN and H. SCHWABE-BURCKHARDT. *Basel: Verlag Helbing und Lichthahn*, 1956. 9½×7 *inches; 214 pages; map*

Most of the published letters written by that excellent Swiss explorer, J. L. Burckhardt (1784–1817) from the Middle East to members of his family lie buried in Swiss periodicals long out of print. These, with other letters, have now been republished by two descendants of the family. Burckhardt, like Mungo Park and other African explorers, was engaged by the African Association of London to penetrate the vast region south of the Sahara which he planned to approach by way of Fezzan, a direct though most arduous route. This methodical young man prepared himself for the journey in a conscientious way by making a preliminary tour through Syria and Palestine to Egypt chiefly to accustom himself to the Muslim way of life and to learn literary Arabic. On his arrival in Cairo from Sinai he found the way to Fezzan temporarily closed, so he filled the interval of waiting by travelling to the Sudan, crossing the Red Sea and making the pilgrimage to the Holy Places of the Hijaz. It would have been infinitely simpler for him to have taken ship from Suez or Qusair to Jedda, but Burckhardt chose to go slogging up the Nile Valley as far as Shendi where he turned east to Suakin and said his prayers in Mecca. He had traversed the sultanate of Sennar in the last days of its dissolution and is incomparably our best witness of the times. But the gruelling hardship of the journey wore him out and he returned to Cairo only to die of dysentery; his mission to Fezzan and the Niger went unfulfilled.

The letters from Egypt form a useful commentary on the country as it was a few years before Edward Lane came to live there, and to record a way of living which has not even now departed from some of the more conservative quarters of the capital. And they reveal the more intimate side of the man whose solid worth is already seen in his posthumous works of travel in Syria, Egypt, the Sudan and Arabia. Burckhardt was an ideal traveller in Muslim lands; he was knowledgeable, modest, sensitive, observant, tough. And in the Day of Judgement it may be remembered of him that he made the pilgrimage as a devout Muslim. In this he stands apart from those other travellers who, for a variety of motives, from love of learning to lust for cheap fame, have made the pilgrimage under false colours.

The text of the letters is preceded by a short "life" and is followed by an index-glossary of persons, places and technical terms mentioned in the letters, and a bibliography remarkably complete in English and German references. It borders on pedantry to cavil at two or three trivial mistakes in the glossary which require no great learning to correct. For instance, *aga* (p. 191) has a complicated number of different meanings not perhaps realized by the editors. The correct date on p. 198, line 3, for the beginning of the French occupation of Egypt is 1798. "Bedscha" (p. 199) is not another word for Bisharin but is the name of a tribal group which includes the Bisharin, Hadendoa and Hallenga. Mohammed Ali (p. 203) was not strictly "Vizekönig" but simply governor (*vali*) of Egypt, though an Englishman is in no position to point to the deficiencies of the German language in translating the multifarious gradations of governor in the Ottoman Empire. What is evident in this book is the general good workmanship of the editors who have made these letters available.

RICHARD HILL

EROSION SURFACES IN AFRICA: SOME CONSIDERATIONS OF AGE AND ORIGIN. By F. Dixey. Reprinted from *Trans. Geol. Soc. S. Africa* 58 (1955) 265–80

The description and analysis of African erosion surfaces have proceeded vigorously during the past twenty years. In that progress Dr. Dixey's work has taken a leading part, and the paper under review is an important contribution to our further knowledge and understanding.

In the interpretation of geomorphological process and history there has been considerable divergence of opinion. It is natural that in most British schools of geography, courses in geomorphology pay relatively little attention to tropical forms, and the impact of African landscapes on the British geographer is frequently profound. It is difficult to escape from "temperate" habits of thought and terminology, perhaps particularly the latter. Dr. Dixey's opening strictures on the use of the term peneplain are therefore both timely and welcome. One major difficulty in reaching agreement over African processes has been the unrestricted use of the term "peneplain" for "erosion surface," the former implying (as he indicates) certain processes for formation which the latter term avoids. The difficulty has applied equally in the opposite direction in the occasional reluctance of European geographers to accept under the more familiar name accounts of features which are obviously on a scale totally different from that of the temperate regions.

In seeking explanations for the tropical forms, geomorphologists have evolved a number of differing theories. Of these, Professor L. C. King's theory of pediplanation has probably produced the greatest controversy. The protagonists of rival schools of thought have advanced their arguments with warmth which has no doubt assisted in the clarification of ideas. Dr. Dixey's paper indicates a rapprochement between the differing viewpoints and usefully assesses the comparative parts played by pedimentation and by slope flattening under varied conditions of climate, structure and resistance. His exposition of the composite nature of the processes involved may remove many difficulties of interpretation in areas combining both concave and convex forms. In the belief that, after initial uplift and stream incision, the new surface is roughed out by scarp retreat with subsequent lowering of divides on weak or deeply-weathered rocks, by gradual flattening of slopes, he underlines his preference for terms such as "surface of erosion" or "aplanissement" which carry no particular implication in favour of any one process of formation.

On the dating of erosion surfaces, Dr. Dixey reiterates Professor King's distinction between age determined by initial uplift and initiation of surface development, actual age at any place determined by fossiliferous deposits and comparative age representing the start of a newer cycle. Each method has its difficulties and his general preference is for the first. The inland appearance of a new cycle along the major rivers is taken to be very rapid, so that it is represented over a wide area very quickly and provides a fairly uniform reference datum in time, although subsequent destruction of the older surface by valley widening and scarp retreat may be prolonged, and the actual ages of different parts of the newer surface may ultimately vary widely. The latter point is readily acceptable, but in the experience of the reviewer the former may or may not be well represented, depending, as it does, on length of the rivers and the structure and resistance of the rocks over which they flow; the newer cycle certainly advances comparatively rapidly up the major rivers, but not always with sufficient speed to be regarded as appearing virtually instantaneously (in terms of geological time) throughout the area of the older surface. However, as Dr. Dixey points out, there is as yet no perfect solution to the problem. He indicates the fundamental divergence of opinion regarding the nature of the oldest surfaces, dependent basically on the acceptance or rejection of the concept of an initial Gondwana continent. Various methods of mapping erosion surfaces are reviewed, with an indication that any geomorphologist may wish to vary his method to demonstrate different aspects of his work.

This paper provides a valuable appreciation of the present extent of agreement—and divergence—within the study of African erosion surfaces. J. C. PUGH

AFRICAN TRAVEL

Mr. Lewis Cotlow is best known for his films of African wild life, but his books—of which the latest is ZANZABUKU—DANGEROUS SAFARI (*Hale*, 1957, 18*s*)—show that he is equally entertaining as a writer. Mr. Cotlow is interested in the people he meets as well as in the wild creatures he films, and his chapters on the pygmies of the Ituri forest are full of sympathy and penetration.

In AFRICAN WONDERLAND (*Hale*, 1957, 18*s*) Mr. James Riddell reveals a sharp eye for the absurd, particularly "Africanisms" and native costume, and even those of us who do not share his sense of humour will find his book a diverting account of a journey through Central Africa.

Mrs. Jane Bernard's light-hearted account of life as the wife of a District Commissioner in Togoland (BLACK MISTRESS, *Hodder and Stoughton*, 1957, 16*s*) deserves to become a minor classic, with its picture of an English lady's determined efforts to make a "quaint" mud hut look both cosy and refined. D. WELSH

Miss Mary Rowlatt's experiences as a bird-watcher and social worker provide the best reading in A FAMILY IN EGYPT (*Hale*, 1956, 18*s*), a rather oddly assembled book of family annals. There is very little geography, and her account of a rapid visit to St. Catharine's Monastery is strangely muddled. We are asked to believe that, on her way there, she saw successively: (1) "Pharan," (2) the turquoise mines, (3) the Wadi Mukattab, (4) a hill where an American astronomer had lived (Gebel Katharina) and (5) a garden cultivated by a Greek monk sent by the Monastery. Really, of these (1) and (5) refer to the same place, (2) and (3) should have preceded them, while (4) could only have been seen at the far end of her pilgrimage from the summit of Gebel Musa. No doubt the speed of her passage is to blame for this. Felix Fabri with donkeys saw far more clearly in 1483. G. W. MURRAY

POLAR REGIONS

NORTH ICE. By COMMANDER C. J. W. SIMPSON. *London: Hodder and Stoughton, 1957. 9×5¾ inches; 384 pages; maps, plates. 37s 6d*

It was a brave and far-seeing young naval officer, inexperienced in polar travel, who decided after the war that Great Britain should once more be placed in the forefront of Arctic exploration. This country had done little in the Arctic since the middle 1930's and the gap to be bridged was immense. Other countries had developed special "air dropping" techniques and had gained considerable experience in mechanized polar transport, but apart from Britain's participation in the Norwegian–British–Swedish Expedition (1949–52), her polar techniques were still basically of the conventional pre-war pattern. Commander Simpson, leader of the British North Greenland Expedition, planned an ambitious scientific programme dependent upon these new techniques and in order to make the scientific programme feasible, he took a further novel step and chose a base site on a lake 3000 feet above sea level on the edge of the North Greenland ice sheet, thereby necessitating that the whole expedition's base headquarters be flown in by air transport, involving an air lift of 259 tons!

'North Ice,' the official account of the B.N.G.E., 1952–4, is the complete story of this remarkable adventure. There were twenty-five resident members (including members of all three Services and civilians) and large numbers of non-resident Army and Air Force personnel in this combined operation which lasted two years; to record the work of the expedition completely and readably in one volume is a very difficult task. The authorship is also a combined operation and of the twenty-nine chapters half are written by members other than the leader. In many respects this is unfortu-

nate in that the continuity suffers and each author tends to enter into greater detail of similar routine matters than would a single writer. It is disconcerting too, to go on a spring journey with one party and pass from the cold rigours of early March to the pleasant warm days of May and then in the next chapter find one is back in February again!

Although a highly mechanized expedition the story relates many of the traditional polar hardships as well as many new excitements occasioned by a crashed aircraft, Weasels disappearing into crevasses, and a large flying boat having its hull ripped open and grounded on a wind-swept inland lake, perilously near the end of the flying season. Many of the rather frequent mechanical frustrations were due to the misfortune of having to equip the expedition with war-surplus Weasels for which there was insufficient time and money to ensure a high standard of overhaul before leaving England. However, to have overcome these difficulties and still to have achieved a full programme in the fields of geology, glaciology, meteorology (including the maintenance of an inland station at lat. 78°), extensive gravity and seismic traverses (the former including a crossing of Greenland from east to west), and a comprehensive accompanying surveying programme was a remarkable achievement. 'North Ice' successfully achieves its object in conveying to the reader a very good impression of the wide variety of scientific work carried out, with vivid descriptions of the conditions in which it was executed. These descriptions are brought to life very handsomely with eight coloured plates and fifty illustrations in monochrome. The maps are adequate but inconveniently placed for the reader. A combination of the map on the back-end cover with that on page 45, included as a sheet that could be folded out, would have been very helpful. There is unfortunately no index and the appendices, though very interesting, are short. The latter weakness may be remedied in the account of the scientific work of the expedition, written by the scientists and now with the publishers.

A. STEPHENSON

POLAR TRAVEL

Of the six books under review two concern the Arctic regions, and four (one of them a reprint) the Antarctic. Ejnar Mikkelsen's TWO AGAINST THE ICE (*Rupert Hart-Davis*, 1957, 21*s*) deserves a high place in the "horror" literature of polar endeavour. It tells of a 1000-mile sledge journey in north-east Greenland which he and a companion made in 1910. They were searching for the diaries and records of Mylius Erichsen, who had perished on a previous expedition. Mikkelsen calls himself a professional explorer, and candidly admits that the quest for the records was a providential lever for extracting financial help for another expedition. During the sledge journey he and his companion endured every privation and vicissitude the polar furies could devise, only to prove that the missing diaries had disappeared for ever from a camp on the sea ice. They even had to wait for two long winters on their return to base before being rescued by a passing sealer. Mikkelsen, however, remembers the joys as well as the tribulations of those years with remarkable vividness; he has a gift for recreating incidents and emotions that lifts his book out of the normal run of explorers' tales. Maurice Michael serves him well as a translator, and the illustrations are adequate.

Robert Dovers was "dog man" to the French expedition in Terre Adélie in 1952. The night before the supply ship left, the station at Port Martin was destroyed by fire and all but seven of the expedition returned to France at once. The remainder spent a year at Île des Pétrels studying Emperor Penguins, and surveying. Dovers' book HUSKIES (*Bell*, 1957, 21*s*) is an engaging report of the year's happenings as they affected his own work. It is, however, his account of the manners, moods and lives of his charges that give the book its unique interest. From being a mass of identical and anonymous dogs they rapidly displayed distinctive personalities, and taught their master that "the relationship between man and dog is not that of a man and a pet, it is a working partnership." The lives of huskies are a short span of almost unrelieved hardship. Together with normal canine virtues they have an innate brutality that

continually shocked the men; when not working or sleeping they stole, fought and killed whenever opportunity arose. They had their days, however; the picture of a team, well out of control, dragging their sledge wildly from seal to seal across the sea ice is a memorably funny one.

There is a chapter in Dovers' book on Emperor Penguins, a subject elaborated by Jean Rivolier, a member of the same expedition, in his book EMPEROR PENGUINS (*Elek*, 1956, 15*s*). This is not a biological account of *Aptenodytes forsteri*, but a lively and often humorous narrative of the author's experiences as medical officer to the seven men left at Pointe Géologie after the destruction of the Port Martin base. Rivolier tells of the general life of the expedition, of his companions and most of all of the Emperor Penguins, who are given a section at the end of the book in which is described the cycle of their life in this desolate part of the world. Here is a book for the non-specialist who is interested in the polar regions and in penguins; not only are the surroundings of the small base vividly described and illustrated by photographs, but its character and the character of these men, their dogs and the penguins come to life. Amusing are the accounts of the inconveniences suffered by all from the biologist's insistence on trying to rear an Emperor Penguin chick in the hut itself; so too are the troubles and triumph of Aspirin, a husky much persecuted by the rest. The translation by Peter Wiles is pleasantly readable but the place-names have unfortunately suffered anglicization. The narrative complements the more general and more factual account of the expedition by the leader Mario Marret in his 'Antarctic adventure' (reviewed in the *Journal* for March 1957).

The writers of the next two books both set out to paint a more ambitious canvas than their material justifies. N. C. Negri's THE VALLEY OF SHADOWS (*Muller*, 1956, 16*s*) prompts the thought of what a pity it is that nowadays undergraduate and other small polar expeditions feel they must justify themselves by extensive scientific results. It would be far better if the members of such parties could undertake some coordinated piece of specialized research! The pretensions of a four-man expedition such as this one—"the advancement of scientific knowledge in the Arctic peninsula of North Lyngen"—are too much of a good thing. Since the Geographical Survey of Norway (Norges Geografiske Oppmåling) is in process of mapping, on the basis of aerial photography, the area so painfully surveyed from the ground by this party, it seems that much work and effort have been wasted. (See *Geogr. J.* 119, 3 (1953) p. 370, for Professor Gleditsch's comment on a previous expedition to this area.) However, even having accepted the aims of this winter venture in north Norway, one must still criticize its rashness and lack of planning. Mr. Negri has written a book on the strength of his experiences; one cannot help thinking that it adds little to his credit. Photographs and maps are poor; the narrative is readable, but seems to be written mainly for the simple reader who imagines that an expedition to the European Arctic must suffer conditions similar to those undergone by Scott's pioneer journeys to the Antarctic. This is not so, and the fact that a village exists near Mr. Negri's base belies his picture of an unknown land.

The sub-title of THE CONQUEST OF THE ANTARCTIC (*Wingate*, 1956, 16*s*) might well have been "Snippets and Jottings." Designed, according to the "blurb", to give "a preliminary picture of the tremendous activity over the Antarctic," the author, in attempting to summarize the work of past, current and future expeditions in the area only succeeds in giving an inaccurate sketch of the continent and its history, coinciding with public interest in the polar regions during the International Geophysical Year. He is mainly concerned with the activities of present British Commonwealth expeditions, but chapters are also devoted to the establishment and aims of the American and Soviet stations; the work of other nations is briefly described. "Exclusive interviews" with members of the British expeditions reveal that the author has often confused the facts and has not subsequently checked them. Dr. Fuchs, for instance, is described as having a "King Emperor penguin's egg" in his possession. Names and often anecdotes are mixed up or wrongly narrated; chapters are ill-constructed and

paragraphs are strung together with no lead from one topic to the next. The photographs are quite well selected, but do not make up for a poor and "popular" book.

Another reprint of Frank Hurley's SHACKLETON'S ARGONAUTS (*Angus and Robertson*, 1948, 15*s*) has been issued. Hurley was official photographer to the British Imperial Trans-Antarctic Expedition, 1914–17, and gives an unassuming account of that ill-fated venture. The illustrations, fifty-four of the author's excellent photographs, are the meat of the book.

ANN SAVOURS

NORTH AMERICA

WILD AMERICA. By ROGER TORY PETERSON and JAMES FISHER. *London: Collins*, 1956. 9×5½ *inches; 416 pages; illustrations.* 30*s*

This book is the result of a promise which the American author, Roger Tory Peterson, made to his English fellow-ornithologist, James Fisher. "If you come to America," he said, "you will see a more complete cross section of Wild America than any other Englishman and all but a few North Americans have ever seen." To carry out this promise Mr. Peterson organized a tour which took the authors over 25,000 miles in a hundred days. They passed through the great hardwood forests of the Appalachian Chain, the steaming swamps of Florida, the sun-painted deserts of Arizona, the great canyon of the Colorado, the cathedral aisles of the western conifer forests, and the barrens of the Alaska coast, to end on the fog- and seal-infested islands in the Bering Sea. In the course of this journey they saw over 600 species of bird, and broke the record for the number of species seen by one observer in one year north of the Mexican border. Tours of this kind have rarely been made by naturalists, and many will wonder whether such an experience can yield a book that is anything more than a catalogue of "and then we saw so-and-so, and then . . ." Such fears are not realized. For, while birds dominate these pages, they are presented amid their background of landscape, plants, and human activities, in what is really a travel book with a bias towards natural history. This reviewer did shy at certain statements, among them Mr. Peterson's resolve to "do things up brown and try for a record," and his revelation that Mr. Fisher greeted each new species with shouts of "Tally Ho!" (or even, on one occasion, "Tally most incredibly ho!"). But in general the narrative flows pleasantly, and its vivid descriptions are enormously enhanced by numerous black-and-white illustrations from Mr. Peterson's pen. The authors succeed (and at a very reasonable price) in giving us an account of their experiences which most naturalists will read with mingled enjoyment and envy. Moreover, although at first sight this may seem to be a superficial narrative, it yet contains much for us in Britain to ponder upon. In particular, it tells of the relationship between the American people and their land; among other things of how a highly mechanized and industrialized people have found so much of value in the natural beauty of their country that they have spared neither money nor effort in its preservation. Reading of the work of the National Parks Service and of the Fish and Wild Life Service, we may reflect on our own paltry efforts at conservation, and be ashamed.

M. W. HOLDGATE

BRITISH COLUMBIA ATLAS OF RESOURCES. Edited by J. D. CHAPMAN and D. B. LEWIS: cartographic editors, A. L. FARLEY and R. I. RUGGLES. *British Columbia Natural Resources Conference, Department of Lands and Forests, Victoria, B.C.*, 1956. 22×17 *inches; 92 pages*

To mark British Columbia's centenary, which occurs next year, a remarkable atlas has been published—"The B.C. Atlas of Resources," detailed and exact enough to satisfy the specialist, yet so clear and attractive in production and presentation as to be of great value to teachers and students and of more than passing interest to the average citizen. It was published in the latter part of last year by the B.C. Natural Resources Conference, a body composed of representatives from the provincial government, the University of British Columbia, and from industry. More than one hundred persons were engaged in its production, which took more than two years.

The atlas is unique in Canada as it is the only one of its kind ever published. For the past nine years, the B.C. Natural Resources Conference has made the transactions of its annual conferences available to the public in the form of a most readable-report, illustrated with numerous maps and diagrams. A complete inventory of the resources of the province was made in 1949, and in 1954 it was decided to present this in the form of an atlas that would have both a specialist and a wide popular appeal.

About half of the 92 large pages are devoted to coloured maps, those occupying a full page being drawn to a scale of 55 miles to 1 inch. Opposite each map there is a page of text, tables and diagrams, and one or more excellent photographs. For the maps, transparent colours (yellow, red, blue, purple, green and grey) are used, and used most effectively. The first part of the atlas deals with land forms, geology, climate, soils and other geographical distributions, while the maps of the second part demonstrate the utilization of the natural resources—forestry, fishing, mining, manufacturing, transport, etc. Index maps show the areas covered by maps published by the B.C. government and the extent of air surveys and air photography. Prints of air photographs are stocked by the library of the Department of Lands and Forests (Victoria, B.C.) and are available on loan or for purchase at most reasonable prices.

J. S. GREGORY

PACIFIC

NEW LIVES FOR OLD: Cultural transformation, Manus, 1928–1953. By MARGARET MEAD. *London: Victor Gollancz*, 1956. $8\frac{3}{4} \times 5\frac{1}{2}$ *inches;* 548 *pages; plates.* 25*s*

As is the case with most of Dr. Mead's work, this volume can be read with several purposes in mind. After an absence of twenty-five years she returned to the scene of previous field work on the south coast of the Great Admiralty Island, Manus. The story of what she found and the changes wrought in large part by the fact that some million American soldiers had passed through the Admiralties during the Second World War make fascinating reading. As she insists, no one could have foreseen such an extraordinary event a quarter of a century ago, so that the document gives, in part, an example of the significance of historical accident and the consequent impossibility of accurately predicting social development. On the other hand, the book can also be read as a case study in the effects of child training on adult behaviour, and Dr. Mead elaborates her data to show that the particular training given the Manus child twenty-five years ago made it possible for him to assume a quite different adulthood than that of his father and grandfather. Because Dr. Mead's original interests included a study of child training, she is able to say how present-day adults acted when they were children and how they were treated. Her material is thus rich in the human aspects of culture change.

Dr. Mead pays considerable attention to the methods by which her data have been obtained. This book can also, therefore, be referred to as a study in field method. She cites her present methods and those she used twenty-five years ago. Also, because Dr. Mead's work is always essentially comparative, 'New lives for old' may be read for its asides on Western, particularly American, life. Some of these asides are well worth closer attention.

Despite the interest of these various aspects of the book, it may prove valuable to dwell here upon the *fact* of change in Manus. In 1928 the people were almost naked and completely illiterate "savages" living in pile dwellings in the sea—denizens of the Stone Age. In 1953 they had moved to the land and were "potential members of the modern world, with . . . responsibility to God, enthusiasm for law, and committed to trying to build a democratic community, educate their children, police and landscape their villages . . ." (pp. 21–22). In outlining the "how" of this transformation, Dr. Mead emphasizes that the Manus have moved faster than any people for whom we have records. Certainly there are no other instances in which both the "before"

and "after" stages have been observed and documented. Yet it should not be thought that the Manus constitute a unique example.

There are numerous instances of people who have succumbed to the sudden influx of Western culture. They have yielded to the domination of a superior technology and given up their values without being able fully to incorporate any of those of the foreigner. These sad cases have conditioned us to thinking that this is the necessary direction of culture change. Africa is teaching us otherwise, and there have also been several small groups which made rapid, and thorough, adjustments. One such group was the Creek Indians, a tribe of what is now the south-eastern United States. These Indians quickly accepted White standards. They could muster native ministers of the Gospel, solicitors, business men and school teachers who were as well-trained and as capable as those of their White neighbours. But what was the result of this astounding adaptability? In the 1830's the Creeks were illegally deprived of their lands and forcibly removed to a distant reservation. They never recovered from this blow and, although individuals of ability still bore witness to former Creek strength, the group had lost its identity. Its valiant progress had gone for nothing.

The same thing happened on a somewhat smaller scale with a group of American Indians in the area of the present city of Tacoma, Washington. Their first direct contacts with White civilization came in the 1840's. Twenty-five years later an advanced Indian school was started at Forest Grove and the eighteen boys who constituted its first student body all came from the Tacoma region. One of these boys became a Presbyterian minister, others were successful business men. This startling adaptation, however, was made by individuals and had no group consciousness which could give it direction. Unfortunately, it proved abortive and the gains in progress were followed almost immediately by such a decimation of population as to terminate the experiment.

The Manus, therefore, are not the only people to have moved from the Stone Age to civilization in a short time—unusual as such a feat may be, and unlikely as seems the possibility. The great difference in their case lies in the recency of the adaptation and the political complexity of the modern world in which their way must be made. Strangely enough, the Manus have accepted the political complexities of the twentieth century. Whereas the American Indian adjustments were mainly economic, theirs is largely political. The question one asks is whether their fate will be happier. When the Manus have done so much themselves, it would be a great human waste were they not to succeed. They are a small group, it is true, but here is human drama at its most intense. If the book had concentrated upon it, it would have made easier reading. But Dr. Mead teaches theory while she cites her case. Do not let the theory put you off for if you do you will be missing a fascinating human story. MARIAN W. SMITH

WORK AND LIFE ON RAROIA. By BENGT DANIELSSON. *London: Allen and Unwin*, 1956. 9×5½ *inches; 244 pages; maps, photographs and illustrations.* 25*s*

This scholarly study of life and work on Raroia, an atoll in the Tuamotu archipelago, will be welcomed not only by anthropologists, for whom it is intended, but also by geographers interested in the island peoples of Oceania. The author, a Swedish anthropologist, is interested in the effect of Western culture on non-European communities. He tells us that he chose Raroia, a French Dependent Territory, because the population was small enough to be studied in its entirety—in 1950, the permanent population amounted to only 116 persons. Moreover, he seems to have secured the wholehearted cooperation of the Raroians in his investigations; his sensational arrival on the island as a passenger on the Kon-Tiki raft seems to have swept away any reluctance the Raroians might have had against answering "all the trying questions an anthropologist can ask," and they treated him as one of themselves. He had earlier acquired a working knowledge of the Tuamotuan dialect in Tahiti.

Dr. Danielsson's main task was the collection of certain basic facts about the atoll and its inhabitants, including the taking of a detailed population census. He studied

the social and political organization, the system of land tenure, the economy, and the movement of peoples to and from the atoll. Geographers will find of particular interest the first chapter "Environment and natural resources." It contains a list of Tuamotuan and pan-Polynesian words for topographical features which should be of value to the physical as well as to the human geographer. The author, although concerned essentially with a field study, has turned to historical documents whenever they throw light on a situation today. The book makes pleasant reading—it is illustrated with diagrams and photographs—and can be recommended to all students of South Pacific affairs.

E. M. J. CAMPBELL

PHYSICAL AND BIOLOGICAL GEOGRAPHY

DIE ENTWICKLUNGSGESCHICHTE DER ERDE: mit einem A.B.C. der Geologie. Edited by HANS THOMAS. *Leipzig: VEB Brockhaus Verlag*, 1955. $7\frac{1}{2} \times 5$ *inches;* 652 *pages; maps, diagrams, photographs. DM* 12.15

This Brockhaus handbook is the geological companion volume to the Brockhaus handbook of physical geography 'Das Gesicht der Erde' (reviewed in the March *Journal*). Like the latter it offers short clear descriptions, illustrated with many figures, of the various aspects of the subject. Thus mineralogy, palaeontology, structural geology, etc., are all considered and there is a most interesting chapter on the history of geology. It is always revealing to read a foreign account of the development of a subject; British names are, of course, numerous (including William Smith "Schichten-Smith"), but many little-known foreign scientists who contributed to the growth of the subject are also named. In the sections on structural and physical geology and in the dictionary there is inevitably some overlap with 'Das Gesicht der Erde,' for in Germany, as here, morphology is considered to be part of both geography and geology. The other sections vary widely in their immediate importance to the geographer, but most notable is that dealing with historical geology or palaeogeography, the longest section of the book save for the dictionary. This has a decided emphasis on western and central Europe, *e.g.* with few exceptions the illustrative maps in the text show an area extending from the Orkneys to the Gulf of Lions, and from Ireland to Leningrad. For the area thus delimited, however, it will be a valuable reference, providing, in particular for Germany, as much detail of the stratigraphy as most geographers are likely to require, even at an advanced level. For the specialist it provides for Germany a useful supplement to Gignoux's 'Géologie stratigraphique.' In addition to the maps, this section contains some useful stratigraphical tables. Indeed the handbook as a whole is profusely illustrated, and contains a good index.

E. M. YATES

STRUCTURAL GEOLOGY. By L. U. DE SITTER. *London: McGraw-Hill*, 1956. $9\frac{1}{4} \times 6\frac{1}{4}$ *inches;* 552 *pages; diagrams.* 67*s* 6*d*

It is natural that a book intended for trained geologists should contain subjects of a controversial character. This book is no exception, but it stands apart from most other books dealing with this subject in presenting facts and hypotheses with distinctive clarity. The opening chapters deal with the application of laboratory techniques to the behaviour of rocks in the field, and from these the reader will derive many new ideas and a clear understanding of established principles of cleavage, schistosity and fracture. The section dealing with comparative structural geology makes great use of published sections from many parts of the world. As a collection of examples they are enormously valuable and the treatment of the subject is lucid and stimulating, as the author frequently advances his own views on the interpretation of many of the more controversial types. In dealing with the characteristics of faults, accepted views are fairly treated and the diagrams are excellent. In the chapter called "Geotectonics" de Sitter has made great use of his experience and I am sure the views expressed on subjects like magmatic phases in orogenesis, the origin of island arcs and shields will

attract attention. In brief, this book will stand among the best books published on any aspect of geology and will bring many geologists to the realization that ultimately a mathematical approach is essential to the study of structural geology. W. DAVID EVANS

THE BEHAVIOUR AND CONTROL OF RIVERS AND CANALS. By Sir CLAUDE CAVENDISH INGLIS. Research Publication No. 13 of the Central Waterpower Irrigation and Navigation Research Station, Poona. *Poona: Yaravda Prison Press*, 1949. 2 vols. 14×8½ *inches; 487 pages; figures and indices.* 25*s* 6*d*

The format of government and other official reports is frequently forbidding, and these volumes with their wealth of details of engineering constructions are no exception. This report is essentially a compilation of many of the investigations carried out by the Central Waterpower Irrigation and Navigation Research Station, Poona, between 1916 and 1945, and will be of greatest interest to water engineers. Nevertheless, there is much material included which will repay the geographer who ventures into these fields and who will probably find the chapters dealing with "Flow in alluvial channels," "Meandering in rivers," and "Behaviour in rivers," particularly valuable.

There is a useful assemblage of definitions and measured data on the regime of rivers and canals flowing in alluvium which is not easily available elsewhere, and which is supplemented by a large number of maps and diagrams. These, providing as they do a detailed record of the variations in stream channel course and form in response to natural and artificial changes observed during the past thirty years in many parts of India, command the attention of geomorphologists who are concerned with the behaviour of alluvial rivers. In the light of current discussions it is useful to see quantitative demonstration of the direct relationship between river discharge and meander size; and the suggestion that there is some link between the width of meander belts and the size of material in a charge deserves further investigation.

It is interesting to see isostasy and eustacy considered among the factors determining the rate of rise of flood levels in Sind but the results so far do not throw much new light on the silting of the lower Indus. It is suggested that isostatic depression, similar to that in the Mississippi area, has been occurring in Sind.

Much of the research has been carried out on models and there are sections in the report in which the problems of scale and various methods of overcoming other limitations of models are discussed. These contain information gathered over years of experience which anyone concerned in constructing similar models will find valuable. G. E. GROOM

THE WORLD OF WATER. By J. GORDON COOK. *London: Harrap*, 1956. 8×5 *inches; 192 pages; illustrations.* 12*s* 6*d*

Here is another book in which J. Gordon Cook aims to present science to the layman, and describes in florid language some of the properties or functions of water. In each chapter the author concentrates on one major aspect and demonstrates in particular some of its implications on modern living. The chapter headings, which include, for example, "Raw materials from the sea," "Water fit to drink," and "Water attacks our land," give some indication of the interest and scope of this work.

The value of directing our attention to the important rôle of water in this world is great, and the author is to be commended upon the general concept of the work. It is therefore particularly unfortunate that the presentation in non-technical language should take this form. A more restrained and less dramatic style could present the same information much more clearly and without the casual over-generalization against which the honestly enquiring mind is likely to react.

The reference to the Gulf Stream as a "river of warm blue water" is anathema to any geographer and cannot be claimed to be a non-technical improvement on more conservative descriptions. Similarly, in the section dealing with the relief of the ocean floors the author touches upon the theory of isostasy and without any explanations or

qualifications speaks of "The sedimentary rocks and granites of the land" as "floating like huge rafts upon the basalt," so that it is quite natural for him misleadingly to describe the ocean bed as "the basaltic rock on which the waters of the world are floating." Again, in implying that sea plants show a much better adaptation to their environment than land plants by virtue of their simpler structures, the author is really begging the question and imputing to these organisms a power of self-determination that is scientifically improbable. It is surely inadmissable, except in romantic fables, for plants to have emotions, so that Cook's description of the sea plants as flourishing "with an enthusiasm that is seldom matched on land" may perhaps be taken as typical of the author's enthusiasm which runs away with his pen, and which also results in a regretably disjointed presentation. G. E. GROOM

A WORLD GEOGRAPHY OF FOREST RESOURCES. Edited by S. HADEN-GUEST, J. K. WRIGHT, E. M. TECLAFF for the American Geographical Society. *New York: The Ronald Press*, 1957. 10×7½ *inches;* xviii+736 *pages; illustrations.* $12.50

This ambitious publication consists of thirty-one chapters contributed by thirty-five authors. The American Geographical Society is to be congratulated on having secured the cooperation of so many acknowledged authorities, most of them of high reputation in their own fields. The first section (Chapters 1–5) deals with general topics; Chapters 6–30 cover in turn the principal forest regions of the world; in Chapter 31 an interesting attempt is made to digest this mass of material. The outstanding contribution in the first section is J. W. B. Sisam's chapter on "Principles and practices of forestry," which must be one of the best and most concise answers ever written to the question: What is forestry? Although it sets out to cover almost every aspect of the subject in the space of a few pages, it succeeds nevertheless in maintaining a high literary standard.

The authors of the twenty-five regional chapters faced tasks of varying complexity according to the number of administrations represented in their regions. The American continent is covered in five chapters; the longest of these (Chapter 8) is particularly readable and gives a clear and balanced picture of the present position of United States forestry and forest products industries. As an introduction to United States forestry it is possibly the best commentary of its length that a European forester could find to read. Five chapters are devoted to Europe including Mediterranean Europe. With one exception all the important countries are well and competently covered. Unfortunately, however, Chapter 12 on the British Isles falls conspicuously short of the high standard set by other contributors. Something of this sort might have passed as a description of British forestry in the twenties, but of the position in 1956 it gives a picture which is neither complete nor balanced. It is surprising that with a space of no less than fifteen pages at his disposal a forester of R. St. B. Baker's experience should have chosen to ignore such topics as competition for land, the future of commons, the rabbit problem, heathland reclamation, mechanized afforestation, dedication, reserves of growing trees and the salient points of national policy behind the Forestry Acts of 1947 and 1951. The authors of some of the chapters that cover Asia and Africa are handicapped by scarcity of reliable information, by difficulties of correlating information obtained from different governments and by the lack of organized forest management in some of these regions. Possibly more, however, might have been made of the chapters on Pakistan and India. The casual reader would hardly gather from what is written that these countries have led the world in the science and organization of tropical forestry.

The last chapter deals with the outlook for the world's forests and their products, making an interesting and competent attempt to digest and draw conclusions from the contributed material. A reader might do well to start with a glance at this chapter and to read the rest with one of the more important conclusions in mind: "The forest problem of the world is the problem of making the best use of the forest land within

reach. We are deluding ourselves if we expect the solution to come from the inaccessible forests." W. A. GORDON

INTRODUCTION TO THE BOTANY OF TROPICAL CROPS. By L. S. COBLEY. *London: Longmans, Green*, 1956. 8½×5½ *inches;* xv+357 *pages; illustrations.* 37*s* 6*d*

For a world power, with many special interests and responsibilities in the tropical belt, Great Britain does little to instruct its sons in the botanical wealth of these territories. The young botanist visiting Singapore will probably be presented with a basket containing lichis, chikus, passion fruit, papaya and mangosteens and it is almost certain that not one of these delicacies will be known to him. He may find himself in a district of the same city heavy with a unique and penetrating odour; it will be coming from the durian stalls laden with these extraordinary and monstrous, yet delectable, fruits. Soon, in fact, he will begin to realize that his botanical training has given him a rather poor picture of the riches of the plant kingdom.

Nevertheless, it is to Britain's credit that she has been responsible for much of the pioneering and research in tropical agriculture. Amongst several outstanding books, H. F. Macmillan's 'Tropical planting and gardening' has long been an essential for the intelligent traveller. On the other hand, there are very few general accounts of the botanical aspects of tropical agriculture designed for the student. Not only for this reason, but also because it is very readable, provided with excellent photographs and pleasantly produced, Mr. Cobley's book should receive a general welcome.

The economic products of tropical plants are, of course, innumerable. Mr. Cobley knows which enter most prominently into the world's commerce and this may account for omissions of crops which have certainly been of importance or are of botanical interest. There is no mention, for example, of Gutta-percha, the electrical properties of which have only recently been equalled by synthetic substances, nor of the conspicuous variety of the coconut, the "King Coconut," of Ceylon. The durian receives only a mention and who could form from the statement that it is "characteristic" any idea of the exquisite flavour of the chirimoya?

There are a few other minor points. American students, not knowing it to be *Phaseolus lunatus*, will be puzzled by the apparent omission of the Lima bean. Botanists would have been helped by placing the family after the Latin names used as heads of sections. Interested students would have profited by fuller references to the researches into the origin of maize, a fascinating botanical detective story.

These criticisms do not lessen the value of Mr. Cobley's book and he is to be congratulated. PETER BELL

THE HISTORY OF THE BRITISH FLORA: a factual basis for phytogeography. By H. GODWIN. *Cambridge University Press*, 1956. 11¼×9 *inches;* 384 *pages; plates, figures.* 90*s*

The flora of every country is always changing and almost every year, even in these islands, there are additions to the list of plants which are apparently "wild." Some of these are unquestionably introduced and will spread if they can compete successfully; others, more interesting, are clearly survivals from the past which have somehow been missed. The point is, what past, and how long ago? Most of the species we know in Britain today have been here throughout historical times: but what happened during the Ice Age and after it, when and where was Britain severed from the Continent, what has been the pattern of change in the vegetation which survived or arrived, why are so many plants now so restricted in distribution and, if immigrants, where did they come from and how did they come? Such questions are in the field of plant geography and can only be answered by delving deep, as this book does, into what is called prehistory in other studies.

Serious botanical research of this kind began here at the end of the last century with Clement Reid's work on fossil fruits and seeds, culminating in his book, 'The origin of the British Flora.' But the sequence of geological, archaeological and

climatic events was still ill-defined. The last thirty years have seen an extraordinary advance in the knowledge of Pleistocene geology all over Europe, as well as progress in the correlation of the cultures of prehistoric and Neolithic man with the glacial and post-glacial stages. Above all, the technique of the analysis and identification of fossilized pollen has been developed and has enabled workers to reconstruct vegetational stages controlled by climate in the Quaternary period. Obviously, the forest trees with their abundant pollen were usually the dominant element and provide a picture of the environment of plants and animals in primitive societies. But a most impressive number of herbs and weeds has also been identified. This book shows, for instance, that some of our supposed "colonists," such as poppies, have been "native" here since Late Glacial times, though they are today characteristic of made ground. Even more interesting is the discovery that many of our rare plants which are now so restricted as to suggest theories of survival in ice-free habitats were really widespread in Britain in the Late Glacial period. Such work is, of course, complicated by the limited nature of the deposits, such as mud and peat, in which fossils are found, by the wind-bearing factor, and by the possibility of error in the identification of such *minutiae*.

Dr. Godwin has for a long time been the leading British worker in this field of research, and his remarkable book brings together all the discoveries and records of recent years. It is illustrated throughout with maps and diagrams, and includes a list of sites investigated and a bibliography. The author begins with chapters on the collection and identification of plant remains and the "background scale" of Quaternary change, in which he gives descriptions of Glacial and post-Glacial events, the formation and stratification of bogs, carbon-dating and pollen analysis. The main body of the book is really a "Prehistorical Flora" of the British Isles, a systematic list of all the vascular plants of which fossil material has been discovered and studied, with localities and references to published records, and often with most valuable comments. Here we have, for example, a discussion of the native status of the Beech, which had long been doubted. The final section sums everything up and is an extremely stimulating account of the pattern of change in our flora between the Tertiary era and the beginning of that Sub-Atlantic period which continues to the present day.

This is not a book for the general reader, but every student of the history, geography and biology of these islands will be fascinated by Dr. Godwin's *recherche de la plante perdue* which, so far from being a flight of the imagination, is a deeply rewarding excursion into the world of fact. N. Y. SANDWITH

HUMAN GEOGRAPHY

ECONOMIC GROWTH OF BRAZIL, INDIA AND JAPAN. Edited by S. KUZNETS, F. E. MOORE, J. J. SPENGLER. *Durham, N.C.: Duke University Press; London: Cambridge University Press*, 1956. 9×6 *inches;* 613 *pages.* 94*s*

This volume, compounded of the labours of three editors and fourteen authors, runs to six hundred pages of closely packed theoretical analysis and detailed historical surveys of trends in the three countries concerned. To the reviewer there are several points of interest. In the first place the choice of countries suggests at first sight some easy contrasts: the immense size and relatively small population of Brazil contrast particularly with the small area and dense population of Japan; Japan in turn with its high degree of industrialization and urbanization contrasts with heavily populated, but agricultural and rural, India. Clearly, had that been all there was to it, there would have been no book, or at any rate no worth while book. Secondly, the arrangement into three parts, "Agricultural, industrial, and related economic trends," "Demographic factors and economic growth," "Social structure, the state and economic growth," has both advantages and disadvantages. Against the conspicuous merit of permitting for each part an introductory chapter devoted to a critical appreciation

of the relevant concepts and of methods of measurement, followed by an application of these concepts in an historical study of various aspects of economic growth in the countries concerned, a good deal of repetition can be cheerfully accepted. Thirdly, whatever the title of the book may imply, there is in fact no direct comparison of the countries concerned, and to a reader who has taken the essential point of the first chapter it will be clear that that is not an oversight but is inherent in the nature of the problem. The only direct comparison in the book, indeed, is in the last chapter but one, and there it is between Japan and China in respect of their social organization before the industrial era. For geographers at large the chief value of the book is surely to be found in the theoretical or analytical chapters. These are especially Chapter 1, "Problems in comparisons of economic trends"; Chapter 7, "Population and labour force in relation to economic growth"; Chapter 11, "Social structure, the state, and economic growth." In addition the treatment in Chapter 9 of essential prerequisites of industrialization in under-developed countries should be made compulsory reading for all geographers! The material assembled on agricultural and industrial development, population growth and migration, urbanization, state enterprize and so on in Brazil, India and Japan is good in itself and is admirably organized and expounded, but is, in general outline at least, better known. An expensive volume, but excellent value for money.

R. O. BUCHANAN

RAILWAYS AND GEOGRAPHY. By A. C. O'DELL. *London: Hutchinson's University Library*, 1956. $7\frac{1}{2} \times 4\frac{3}{4}$ *inches; 200 pages; maps and diagrams.* 10s 6d

This is another volume in the geographical series of Hutchinson's University Library, edited by Professors Wooldridge and East, a series which already contains many valuable contributions to geographical thought and interpretation. Professor O'Dell has a long-standing interest in transport problems, and the editors could hardly have chosen a more appropriate author. The first five chapters are broadly concerned with the physical background to railway development and operation, with a passing glance at some of the men who made early railway history, both in Britain and abroad. Chapter 6 is entitled "The railway reticule," and in sixty-six pages the reader is taken on a rapid tour of the world's railways. There follow three short essays, on railway services, on the urban pattern, and on rivals to the rail.

At first sight the contents might appear to be little more than a collection of odds and ends, and indeed the title indicates clearly that we are not to expect a systematic railway geography. But it is a pioneer exposition, and collects within two covers a great deal of information, and many ideas and interpretations which are seldom adequately dealt with in geographical text-books. In Chapters 3–5 the many geographical and geological factors which help and which hinder railway construction and operation are lightly sketched, with widely-drawn examples. Gauges, gradients, curvature, tunnels, are related to the physical environment, and the effects of various climatic and weather phenomena are outlined. Fuel and water problems are discussed, with just sufficient technical detail to provide a relatively simple story.

The section on "The railway reticule" is less satisfying. It is impossible to cover the world's railways in sixty small pages, and perhaps it might have been better not to try, for the result can be little more than an annotated catalogue. The treatment is very unequal: thus Europe, which has a denser network of railways than any other continent, abounding in fascinating relationships to the physical and economic environment, is dismissed in seven pages, whilst Australia gets twelve pages and Latin America ten pages, with almost every line mentioned. The treatment of the urban railway pattern presents nothing new; and the chapters on railway services and on rival transport media are but sketches. In some ways it is a pity that this book had to conform to a pattern set by the other volumes in the series. It could have been so much better, twice the size, and with adequate maps and diagrams. Professor O'Dell has so much valuable material at his disposal that one hopes he will take the hint.

S. H. BEAVER

ECONOMIC GEOGRAPHY OF INDUSTRIAL MATERIALS. Edited by ALBERT S. CARLSON. *New York: Reinhold; London: Chapman and Hall*, 1956. 10×7 *inches;* 494 *pages; maps and illustrations.* 100*s*

INTRODUCTION TO WORLD GEOGRAPHY. Edited by GEORGE KISH. *London: Constable*, 1956. 9½×7 *inches;* 634 *pages; maps and illustrations.* 75*s*

Within the compass of less than 500 pages of a book produced on a scale lavish even in the present American context, Professor Carlson has brought together some twenty-six experts from the fields of economics, agriculture and industry. It is an admirable example of the economic geographer fulfilling his function as integrator. Having gone so far, it is a pity from the point of view of the academic geographer that he did not go further; that he did not distil from this extensive collection of up-to-date information on American production some general principles of economic geography. Perhaps this criticism is unfair in that this work, despite its title, is designed to serve the business man rather than the geographer—the cover claims that "Industrial management will find Carlson's book indispensable" and that "Bankers, investment counselors, and individual investors will find in this book unbiased factual information essential to high profit, low risk investment." If true, these claims destroy one's conception of the American industrialist. In orientating his book in this way, the feeling is gained that Carlson has inadvertently hit the stallholder rather than the coconut at which he aimed. In detail, the book is to be complimented on stressing the place of technology in economic geography; on furnishing extensive material against which the theories of industrial location, from Weber to Hoover and Wilfred Smith, may be tested; on the quality of the diagrams. The maps, on the other hand, support the contention that the book is aimed at the business man.

Professor Kish's collection is much less ambitious in its claims, and less successful in achievement. According to the preface, geography has two rôles—to disseminate "odd and fascinating bits and pieces of knowledge" and "to fit the information brought by sailor and merchant, traveler and pilgrim into a system that would explain the fabric of the world." Certainly it has its "odd bits" which have been organized along conventional lines, but in total it is encyclopædic without being comprehensive and systematic without giving real methodological guidance. Physically the paper and binding are excellent, but the photographs, which are mainly of the "Caucasian shepherd and his flock" type, are badly reproduced and seem to have been selected without any particular regard to their geographic content. With the exception of Crary's contribution on the Near East, the maps tell less than could be gleaned from a third-rate atlas. On the credit side, the facts are up-to-date and the bibliography a good guide to some worth-while reading, but this hardly compensates for a publication which is too expensive for a text-book and altogether elementary.

A. C. WOODCOCK

GEOGRAPHICAL ESSAYS ON BRITISH TROPICAL LANDS. Edited by R. W. STEEL and C. A. FISHER. *London: Geo. Philip*, 1956. 8½×5½ *inches;* x+354 *pages; maps.* 35*s*

In recent years British geographers have been paying increasing attention to the problems of the tropics. The geographical departments in the University Colleges of the Gold Coast (now Ghana), Ibadan, East Africa at Makerere and Khartoum (now the University of Khartoum) as well as the University of Malaya have provided bases from which resident staff have worked, whilst a small but steady stream of researchers from Britain has supplemented their studies. This volume of essays covers samples of the work of both groups. One editor, R. W. Steel, until recently Lecturer in Colonial Geography at Oxford, deals with general population problems in West Africa, R. J. Harrison Church of the London School of Economics with transport problems in the same area. A. T. Grove summarizes his soil erosion research in Nigeria. But tragically the whole collection has lost much of its value by the extraordinary delay in publication. It would seem that most of the essays were written at

least five years ago and seem to have been held up in proof for two or three. Thus Steel analyses mineral exports of 1949, Harrison Church the development of railways before the Volta road bridge was even a serious consideration. D. B. Mather, who was at Khartoum some ten years ago, deals with migration in the Sudan, V. C. R. Ford, formerly at Makerere, with the trade of Lake Victoria on which he has since published a monograph. B. H. Farmer's essay on the Dry Zone of Ceylon was written before his intimate connection with the Land Commission, but perhaps the greatest tragedy is C. A. Fisher's study of the "contemporary" political geography of Malaya, with its careful estimates of the claims of Kuala Lumpur and Singapore as capitals of a united Malaya—"in unity alone lies strength" is the final sentence of the book. Five years ago this book would have had a vital interest, and might well have helped in the shaping of public policy today. It has much material of lasting value, but has lost its topicality. Even E. Paget's study of land use and settlement in Jamaica (Census of 1943) antedates the Jamaican invasion of Britain, and the development of West Indian Federation towards reality. L. DUDLEY STAMP

THE CHANGING WORLD. Edited by W. G. EAST and A. M. MOODIE. *London: Harrap*, 1956. 9×6 *inches;* xxvii+1040 *pages; maps.* 42*s*

It is nearly thirty years since the fourth edition of Bowman's 'New world' [1] was published. The American geographer was deeply impressed by the political transformation accompanying the First World War and sought to present it according to his own particular discipline. He must have been aware before his death in 1950 that his "new world" had itself undergone radical change and that another major effort in description and comment was due. 'The new world' was within the range of one man's scholarship, although that man was a giant amongst the geographers, with the telling experience behind him of cartographical work at the Paris Peace Conference. 'The changing world'—the title itself suggests a less confident approach—is the effort of a team of twenty, drawn from the United Kingdom, the British Commonwealth and the United States. And in the mid-twentieth century, no other handling of this task seems in the least practicable, so much has it grown in bulk and in its demand on specialized knowledge. Moreover, between the appearance of a remarkable piece of individual writing, and the present coordinated survey, came the climax of "Geopolitik," with its unhealthy emotion and its dishonest thinking, a tax on the assurance of any political geographer.

The increase in data is most noticeable in two forms. The Polar regions, a generation ago without headline value for the political geographer, now demand thorough attention. A new topic, that of maritime boundaries, with its original diagrammatic illustrations, forms one of the most interesting chapters in this long book. In his study of the Arctic, Dr. Lloyd handles the more straightforward of the high latitude themes, discussing a region transformed both by the substantial assets of mining and the spectacular growth of aviation from the strategic needs of the Second World War. The Antarctic one, in spite of its present publicity, seems more elusive for the political geographer because, as Mr. Kirwan points out, the intangible motives of national prestige and ambition have played so great a part in Antarctic exploration. These indeed largely explain the soreness over the Falkland Islands Dependencies and the anxiety over the whaling rights. In both Polar regions, the geographer encounters a new type of geometric frontier, the sector demarcation.

The pronounced changes in emphasis in a world study of this kind are as interesting as the appearance of new data. It takes Professor East all his five chapters to explain the dramatic rise of the Soviet Union to its present formidable position. In the Canadian chapters, Professor Tatham and Dr. Nicholson also present a political unit, with an economic and strategic identity unimagined a generation ago. Bowman studied the Asian and African topics largely in the setting of the imperial structures of

[1] Bowman, I., 'The New World,' London: George G. Harrap, 1928. New York: The World Book Company.

Great Britain and France. Such an approach would be unthinkable today, and the careful chapters on the two continents, which are partly studies in the emergence of frantic nationalisms, make up more than a third of the whole work.

In this matter of altered emphasis, perhaps the greatest weakness of the survey appears. There are three interesting chapters allotted to the evolution of the United States as a political unit, and at the end of one of them, there is half a page on the topic of the United States as a world power. Into most chapters, as a matter of course, come allusions to the growth of American influence in this and that region or situation. But nowhere are the implications of American predominance thoroughly discussed as they should be, and one looks in vain for the comments which suggest precise and shrewd judgment on this point. One or two of Bowman's are still more relevant to current affairs. "Whatever degree of participation we (the United States) may finally come to have in world affairs, it will be conditional in many respects and limited in all" (p. 745). "In fact it would seem that oil may furnish the first great test of the ability of the world to agree upon a basis of common action in the case of unevenly distributed and limited resources desired by all" (p. 735).

It is understandable that certain topics of great importance a generation ago should now have shrunk in political conspicuousness. Bowman wrote on Ireland as the first problem of Imperial Britain, and allotted a whole chapter to the future of Constantinople. No such limelight now belongs to Irish affairs; public interest takes in its stride the spasmodic violence on the frontier, and the recurrent but more humdrum matter of economic viability. At the other extremity of Europe, Istanbul is firmly a Turkish port, where Constantinople was an international sore.

In the course of the survey two interesting points of geographical terminology arise. Dr. Fischer plunges once more into the vexed question of "Mittel-Europa," and his chapter is full of interest although no less controversial than any of its predecessors on the subject. (It is perhaps strange that there is no reference to Partsch's classic even if this is now fifty years old.) Professor W. B. Fisher is less wholehearted in his comment on the use of the term Middle East, and the short discussion of the point in the first chapter also seems to beg the question. What was wrong with the geographical conception of Near, Middle and Far East fifty years ago, and must the geographers forever meekly endorse the curious terminology of the service departments in the Second World War? Who is to rectify these misleading descriptive terms of major regions if the professional geographer has not the spirit to do so?

The great burden of this book lies in the collecting and sifting of a mass of factual data and the presenting of it as an orderly whole with the help of comment, diagram, statistical table and bibliographical list. The editors and contributors have carried the load without faltering, and if the contents are clear outline summaries, and not deep studies, the whole is no less remarkable. It suggests that the trained geographer, working as one of a team, is more than any other scholar fitted to produce a world political survey, and that his aptness may come from ruminating year in, year out, on the effects of position, climate, resource and transport on the human groups of the earth, and from recognizing these criteria as dynamic rather than static ingredients of human activity.

For the committed political geographer the prospect is even more strenuous. In a book like 'The changing world,' a part of his contribution to geographical and general political literature is made handsomely, but it is the simpler aspect of his work—intelligent and accurate comment on current affairs. The hard core of his task remains, the evolution of the valid themes of political geography, smothered, as the late Professor Whittlesey ruthlessly explained, to a degree afflicting no other branch of the subject, by the high proportion of speculation to field work.[1] Whatever the success of the present book, and it should be substantial, such geographers will have to turn again to the whittling out of the fundamentals, bit by bit, until this side of

[1] Whittlesey, D. 'The Earth and the State,' p. 590, New York, Henry Holt and Company 1944 (Second edition).

geographical work has enough status and identity to be out of the reach of perversions like Geopolitik.

HARRIET STEERS

GENERAL

THE EXCELLENT AND PLEASANT WORKS OF CAIUS JULIUS SOLINUS. Translated from the Latin (1587) by ARTHUR GOLDING. A facsimile reproduction with an introduction by GEORGE KISH. *Gainesville, Florida: Scholars' facsimiles and reprints*, 1955. 9×6 *inches*. $7.50

The sub-title of this facsimile edition of the "Collectanea" of Caius Julius Solinus indicates its scope clearly: "the noble actions of humaine creatures, the secretes and providence of nature, the description of countries, the maners of the people." Solinus was active in the third century A.D., at a time when the Roman Empire was shrinking and its culture in decline, and he drew much of his information from earlier writers, particularly the elder Pliny. The emphasis on the marvellous and incredible commended it to the general reader as late at least as the sixteenth century, but its influence was at its height throughout the Middle Ages when it supplied cosmographers and cartographers with varied detail, much of it unreliable, on the countries of the known world. As Dr. Kish points out in his short but serviceable introduction, the Hereford and similar world maps are filled with material from Solinus, the most conspicuous instance being perhaps the monstrous races of men which border unknown Aethiopia in the Hereford Map. This version by Arthur Golding, 1587, is the only English translation to have been published. Golding added some comments on the original text in the margins, but, in keeping with the plan of this reprint series, Dr. Kish has not annotated it. To the modern reader the Gothic type, rather closely set, may at first be a little trying, but this difficulty soon passes. It is convenient to have this important source of medieval beliefs about the world complete and in so convenient a form.

G. R. CRONE

MAP AND PHOTO READING. By T. W. BIRCH. *London: E. A. Arnold*, 1956. 10×7½ *inches; 64 pages; maps and photos.* 16*s*

THINGS MAPS DON'T TELL US. By ARMIN K. LOBECK. *New York and London: Macmillan*, 1957. 10½×7½ *inches; 159 pages; maps and diagrams.* 34*s* 6*d*

One thing more than anything else will prevent either of these two technically well produced books from attaining wide employment in the classroom, and that is their cost. Both lead up to the interpretation of maps but by quite different methods, and neither with very great success.

'Map and photo reading' consists of a series of exercises on Ordnance Survey maps of various scales and areas. Well chosen extracts from the maps, illustrating many different problems of map reading, including the relationship of scale to generalization, are accompanied by ground or aerial photographs which are to serve in interpretation as a classroom substitute for actual and generally impossible visits to the regions in question. The organization of a book such as this is difficult, but the solution here is not a very happy one. The maps and related photographs do not face each other, which would have supported the good teacher's aim of "map in hand and the land before us." Indeed the wording of some of the questions implies that Jones will not look over the page to the map extract for the answers, whilst others require a study of the maps before answers about the photographs can be formulated. Questions are designed to occupy at most one or two minutes, but experience with a number of graduates has indicated this to be grossly optimistic in many cases. Some of these difficulties arose from the relatively coarse screen used for reproduction of the photos, especially when the recommended magnifying glass was employed, but in the case of the Cardiff example it was mainly due to the impossibility of orientating map and photograph diametrically opposed and separated by an intervening page. All in all one is left with the impression that the aim of this book could be better achieved less expensively with a film strip and sets of map extracts.

'Things maps don't tell us' is rather an odd book in that one cannot really decide what readership is aimed at. The maps under consideration are small-scale generalizations such as road maps, maps found in atlases and encyclopaedias and at best the 'National Geographic' maps. Naturally such maps do not tell us very much when it comes to detailed land form and settlement analysis unless they are, as in this book, supported and elaborated by such excellent sketches of geographical synthesis as Professor Lobeck has for so long produced. One feels that the method developed in this book is likely to prove difficult to put over safely in the classroom. Given the immense resources of knowledge and experience of a Professor Lobeck one could successfully bring even the generalized abstractions of a small-scale atlas map to mirror reality, but the ordinary mortal's limitations point to the dangers of the method. In an age when accurate large-scale topographic maps of many regions and typical features of the world are available, the appearance of this book must be taken as reflecting the American case of only 25 per cent. topographic map coverage, and a public fed with petrol company road maps and an urge for superficial self-improvement.

IAN MUMFORD

A CONCISE GLOSSARY OF GEOGRAPHICAL TERMS. By J. C. SWAYNE. *London: Geo. Philip*, 1956. 6½×4 *inches;* 164 *pages.* 6*s* 6*d*

A major difficulty met in reading English texts on geographical subjects is the large number of words encountered which are borrowed from other disciplines and particularly from other languages. Often ill-digested by the importer their origin and meaning become obscured and many have taken up a new existence as "colour words" in the classroom jargon of geography.

Reading this pocket-sized glossary of words found in school and university examination papers, with additions from literature likely to be read by students, one cannot but be astounded at the linguistic complexities of geographical vocabulary. The ordinary dictionary meaning of foreign words is often most enlightening but is here largely ignored. Who would have guessed, for example, that "roches moutonnées" are sheep-like mounds on the landscape, or that the "Wadden" of the Netherlands have a much more extensive development as "Watten" in north Germany; that "Karst" is the name for a particular region in North-Western Jugoslavia, formerly Austrian, now called Kras; that "dolina" is Serbo-Croat for a valley; and that "aiguille" is French for needle? Certainly not the reader of this little work, which many masters will either welcome as easy authority for their mystic terminology or scorn for not getting to the root of the trouble, the lack of precise descriptive English. Alexander Knox's Glossary of 1904 still awaits a worthy modern successor.

IAN MUMFORD

THE SOCIETY'S NEWS

MEDALS AND AWARDS 1957

Her Majesty The Queen has been pleased to approve the award of the Royal Medals as follows: *The Patron's Medal* to Professor Ardito Desio, leader of the Italian expedition of 1954 to K.2, for geographical exploration and surveys in the Himalaya and in Africa; and *The Founder's Medal* to Sir George Binney, D.S.O., for contributions to Arctic exploration, with special reference to the use of air survey technique in the Arctic and to the development of university exploring activity. The Council have awarded the *Victoria Medal* to Professor S. W. Wooldridge, C.B.E., for services to geographical studies in this country and for contributions to the study of the geology, geomorphology, and historical geography of south-eastern England; the *Murchison Grant* to Dr. G. C. L. Bertram, Fellow of St. John's College, Cambridge, for services to Polar research and exploration; the *Back Grant* to Dr. R. J. Harrison Church, of the London School of Economics, for contributions to the study of the economic geography of Africa; the *Cuthbert Peek Grant* to Kenneth Blaiklock, leader of the Advance Party, Trans-Antarctic Expedition, 1956–7; the *Gill Memorial* to Dr. J. C. Beaglehole, Victoria University College, Wellington, N.Z., for his work on the achievements of Captain James Cook, R.N., and as editor of his Journals; the *Mrs. Patrick Ness Award* to J. B. Heaney, leader of the Gough Island Scientific Survey, 1956.

GRANTS TO EXPEDITIONS 1957

The Council has approved grants totalling £885 (including £45 from Stephens Bequest) to 18 expeditions in 1957, and 18 other expeditions have been approved; instruments have been lent to 21 out of this total of 36 expeditions. Details are as follows:

Financial aid: Stanley expedition to Belgian Congo (£50); Oxford Expedition to Dhofar (Oman) (£100 plus instruments); Cambridge Tibesti expedition (£75 plus instruments); Nottingham expedition to NW. Spitsbergen (£25); Durham Expedition to Lyngen (£25); Edinburgh University expedition to Cilicia (£75); R.N. Colleges Iceland and Greenland expedition (£50); British Borkou-Ennedi expedition (£125 plus instruments); Central Corsican expedition (£25 plus instruments); Cambridge expedition to Colombian Cordillera Oriental (£20 from Stephens Bequest plus instruments); Cambridge Spitsbergen expedition (£25 plus instruments); Cambridge botanical expedition to Ethiopia (£25 from Stephens Bequest plus instruments); Ethnographical expedition to Afghanistan (£75 plus instruments); Imperial College eastern Iceland expedition (£25 plus instruments); London University speleological expedition to Portugal (£50 plus instruments); P. J. Williams' expedition to Norway (£40); Expedition to French West Africa, led by R. Savigear (£50); Cambridge south-east Iceland expedition (£25 plus instruments).

Approval and instruments: Cambridge Andean expedition; British Ornithologists' Union expedition to Ascension Island; South Karakoram expedition (O.U.M.C.); Yorkshire Himalayan expedition; Imperial College Karakoram expedition; Queen's University Belfast expedition to Spitsbergen; Archaeological reconnaissance in eastern Kalat; Manchester Himalayan expedition; Yorkshire Ramblers Club expedition to the Himalaya; Sheffield University geological expedition to Kilimanjaro.

Approval only: North Sweden Research Group; Cambridge Arnoy expedition; Durham Andorra expedition; Bristol University Greenland expedition; Oxford University Mountaineering Club Stornstein expedition; Borough Road College land use survey of Northern Ireland; University of Melbourne expedition to Lake Mackay; Cambridge French West African expedition.

In addition to the above, substantial grants were made to mountain exploration

and research by the Mount Everest Foundation, constituted by Society and the Alpine Club; and a grant of £40 was awarded to the Stanley expedition to the Belgian Congo by the Geographical Magazine Trustees.

THE SWISS ASCENT OF EVEREST AND LHOTSE

On 17 December 1956 the Society held a joint meeting with the Alpine Club to hear an account of the Swiss ascent of Everest and Lhotse earlier in the year. Sir James Marshall-Cornwall, President of the Society, and Sir John Hunt were joint chairmen. Herr Albert Eggler, leader of the expedition, described the approach to Everest; Captain Fritz Luchsinger gave an account of his and Ernst Reiss' ascent of Lhotse; and finally Dr. H. von Gunten described how he and Adolf Reist became the second pair of Swiss climbers to ascend to the summit of Everest, the first ascent having been made by Ernst Schmied and Jürg Marmet.

The full account of this great Swiss achievement may be read in the *Alpine Journal* for November 1956 (Vol. 61, No. 293, pp. 239–52).

LIBRARY STAFF

Mr. D. Welsh, Assistant Librarian to the Society, left the Society's service at Easter 1957 after being appointed a language supervisor in the East European service of the B.B.C. His place is taken by Mr. G. Dugdale.

THE RECORD

CONTRIBUTORS TO THIS ISSUE OF THE *JOURNAL*

Lieutenant-Colonel G. E. Wheeler is joint editor of the *Central Asian Review*, published in association with St. Antony's College, Oxford, and Director of the Central Asian Research Centre. *Major H. W. Tilman*, Himalayan mountaineer, member of the Everest expedition of 1935 and leader in 1938, was awarded the Founder's Medal of the Society in 1952. *Michael Terry* has been the leader of fourteen Australian inland expeditions, firstly with motor transport and latterly with camels; he was awarded the Cuthbert Peek grant in 1925 for his second expedition. *Guy Arnold* led the Oxford University Exploration Club's 1955 expedition to the Usun Apau plateau in Borneo, and is writing a book about it, to be called 'Longhouse and jungle hut.' *Yehuda Kedar*, on the staff of the Geography Department, Hebrew University of Jerusalem, is now engaged on research on the Negev, the arid zone of Israel. *B. W. Sparks* is a lecturer in geography in the University of Cambridge. *E. H. Brown*, formerly of the Department of Geography and Anthropology at Aberystwyth, and visiting lecturer at Indiana University, U.S.A., 1953–4, is now a lecturer in geography at University College, London. *Richard Merriam* is Associate Professor, Department of Geology, University of Southern California; *James G. Holwerda*, a geologist, is Project Manager for the Ralph M. Parsons Co. of Baghdad.

UNIVERSITY NEWS

THE SCOTTISH UNIVERSITIES

For several years past the staffs of the geography departments in the Scottish universities have met annually for a week-end conference. The 1957 meeting took place at The Burn, Edzell, on February 8–10, under arrangements made by the Glasgow department, and was attended by almost every member of staff in the country. Professor Preston E. James (Syracuse, U.S.A.), who is spending two terms at Edinburgh under Fulbright auspices, was also present. Reports made on teaching programmes and discussion of work in progress made it clear that, in spite of a loss

of status recently suffered by geography in schools, as a result of the Scottish universities' entrance requirements, activity within the field is continuing strongly. On the teaching side, Professor J. W. Watson (Edinburgh) reported that the programme at Edinburgh had been adjusted to increase the amount of instruction in advanced cartography and physical geography, with a corresponding reduction in the number of courses offered in regional geography. At St. Andrews, a revised syllabus in both colleges was reported to be giving an improved integration to geographical studies.

Reports on field work showed that Scottish projects very properly continue to occupy the principal place in the attention of the country's geographers, and discussion concentrated on three topics of primary interest in Scotland—mountain morphology, flooding, and crofting—and the possibility of a regional division of labour between universities in their study. Mr. C. Halstead (Glasgow) introduced a discussion on "A joint survey of periglacial phenomena in Scotland," which revealed that a large number of those present were familiar with conditions above the 2000-foot contour, even if they lacked the persistence of Colonel P. Baird (Aberdeen), who has succeeded in establishing and maintaining, over a period of almost a year, a meteorological station close to the summit of Ben MacDhui (4296 feet).

Dr. R. Common (Glasgow), in introducing the subject of "A hydrological survey of Scotland," called attention to the need for coordinating information on the recurrent problem of Scottish floods, and outlined a project whereby geographers would make good in some measure the present deficiency. The task would call for two types of action; on the one hand, a study of records of past floods and, on the other, the establishment of what were described as regional "flying squads," to ensure the immediate investigation and survey of future flood conditions. Finally, Professor R. Miller (Glasgow) described how students from his department, under the guidance of Dr. J. Caird, had carried out a detailed, croft-by-croft survey of Benbecula and much of South Uist, as a "Domesday Survey" against which might be measured changes brought about in the future by the creation of the guided missiles range in Uist.

J. H. PATERSON

WILLIAM SCORESBY 1790–1857

On 21 March 1857 William Scoresby the younger died at Torquay. His life had been a remarkable blending of very different interests and activities, and he died a respected and admired figure, whose contributions to exploration and science received recognition in his lifetime. A century later we can appreciate certainly no less, and perhaps with added perspective, his remarkable qualities.

Like his father (also William Scoresby), he made a name for himself in the Arctic whale fishery. He was ten when he first made the voyage to Greenland in 1800, and six years later, whaling with his father, he reached the furthest north for a freely navigating ship—lat. 81° 30′ in long. 19° E. (a century and a half later, this has been advanced by only 111 sea miles). He was captain of his father's old ship when he was twenty-one, and became one of the most successful captains in the business. But his interests were far from being confined to his means of livelihood, leading him during the course of his voyages to make all sorts of observations and experiments. They also led him to investigate and place on the map the east coast of Greenland between the latitudes of 69° and 75° N. When he was thirty-two he gave up the sea, was inscribed a member of Queen's College, Cambridge, and took holy orders. His days of adventure were over, but his scientific enquiries were far from finished. He was elected a Fellow of the Royal Society in 1824, and was a founder member of the British Association, which was inaugurated in 1829. For twenty-three years he was parish priest in various parts of the country, concluding with a strenuous period of eight years as vicar of Bradford. He obtained the Cambridge degree of D.D. in 1839. Of poor health, he retired to Devonshire in 1847, when he was fifty-six, and there ended his days.

His contributions to knowledge (he left some sixty scientific papers) are diverse.

The chief, perhaps, is his description of the whaling industry in Greenland and Spitsbergen waters. His 'An account of the Arctic Regions . . .' (Edinburgh, Constable, 1820, 2 vols.), which has become a polar classic, devotes one volume to a "chronological history of the northern whale fisheries." It is written with care, and great attention to practical detail. The second half is in fact a handbook on contemporary practice, and as such an invaluable aid to the whaling historian of today. It is of interest to note that in 1821 an early harpoon gun was taken aboard Scoresby's ship by its inventor for testing. But the tests were apparently sabotaged by jealous harpooners who feared redundancy.

A natural development of his interest in whaling was his work on ice. Ice was the main occupational hazard of whaling; many a ship was beset for the winter, with resulting damage and sometimes loss of life. He records an excellent list of definitions of the terms in use among the whalers, which is one of the corner stones upon which our present ice terminology is built. His description of the behaviour of sea ice establishes a number of good points. For instance, he shows that, contrary to current belief at that time, sea ice can form perfectly well away from land; he makes it clear that floes are basically sea ice, however large in surface area, and that increase in thickness may come from both below and above; and he rightly ascribes the red tint sometimes seen in snow covering an ice floe to the presence of marine organisms. He is not always right, of course; but he advanced understanding in important respects.

His ingenious cast of mind made him especially adept at instrumentation. His "marine diver," the predecessor of the Nansen bottle, was a device for securing water samples at depth, and one of his outstanding contributions was the discovery through it that the temperature of sea water may increase with depth. Another main interest was in magnetism, and in particular in the behaviour of ships' compasses. He produced many papers on this subject, and a measure of the fascination it had for him was his voyage to Australia at the age of sixty-six, the year before he died. His work was of immediate practical interest and use to navigators, while not pretending to make any profound contribution to the theory of the earth's magnetism.

His Greenland survey of 1822 was a remarkable feat for one season's work. It was a labour of love, for no one commissioned him to do it, and it had to be fitted into a normal whaling voyage. He found errors of up to 7° of longitude in the position of the coast (his own positions have been found correct to about 1° of longitude). Many of his place-names are still in use, and in particular Scoresby Sound (named by him after his father) perpetuates his link with the region. He also notably improved the charts of the Spitsbergen coast by careful observation during his many voyages. His interest in survey had still wider results, for his publications, and his advice to men like Sir John Barrow, played their part in the great revival of British exploration in the first half of the nineteenth century.

Scoresby's achievement was pre-eminently the result of bringing a truly enquiring mind to a number of practical problems. His schooling was nothing out of the ordinary, but he was able to attend—rather irregularly—Edinburgh University, and there his friendship with Professor Jameson clearly had a deep influence. He gained greatly, too, from an early introduction to Sir Joseph Banks, and later knew Sir Humphrey Davy. His contribution was in general unspectacular, but none the less solid. One may compare his careful, accurate, and very English account of open boat whaling with Herman Melville's splendid and flamboyant tales of the *Pequod*, and contrast Scoresby's view that "the whale generally exhibits remarkable timidity of character" with Moby Dick's behaviour (even if the species of whale was different). Yet, strangely enough, there may be a link between the two; for there is a sermon of Scoresby's, delivered when he was minister at the Liverpool Mariners' Church, that could have served as the model for Father Mapple. Indeed, this country has not produced, before or since, a polar explorer of more diverse attainments.

T. E. ARMSTRONG

William Scoresby in 1822

ROME BEYOND THE SOUTHERN EGYPTIAN FRONTIER

Mr. L. P. Kirwan sends the following note of an addition and amendments to his article under the above title which appeared in the last issue of the *Geographical Journal*, **123**, 1 (1957), pp. 13–19:

In referring to a statement by E. H. Cary and M. Warmington ('Ancient Explorers,' p. 176, London, 1927) about certain Roman bronze vessels said to have been found near the Sennar Dam on the Blue Nile, I added (page 19, note 24) that these authors gave no source for the report. Dr. O. G. S. Crawford has very kindly informed me that the source of this discovery is given in an article "Archaeological discoveries on the Blue Nile" by F. Addison (*Antiquity*, No. 93, March 1950, p. 15). From the reconstructions there shown (*op. cit.*, fig. 4, type 6), there is no doubt that the vessels are imports from Roman Egypt of, perhaps, the first or second century A.D. They come from a Meroitic cemetery near Sennar.

I should like to take this opportunity to correct two misprints in my article; on page 18, fifth line of the second paragraph, "Philosotatus" should, of course, be "Philostratus." On page 17, penultimate line of footnote, "disapproves" should be "disproves."

CANADIAN GEOGRAPHICAL SOCIETY

The Canadian Geographical Society held their Annual Meeting on 21 February 1957 at which a large audience was addressed by the Rt. Hon. Vincent Massey, Governor-General of Canada. The Honorary Foreign Secretary of the Royal Geographical Society, Major-General R. Ll. Brown, was present at the meeting. Mr. Massey is perhaps the most travelled of Canada's Governor-Generals, and could claim with confidence that "there is very little of Canada's geography that I have not been privileged to see." Mr. Massey dwelt on the importance of geographical study in a country like Canada where so much remains to investigate, and pointed to the St. Lawrence Seaway as an example of how man can influence, adapt and profit from his environment.

PATTERNED GROUND IN NORTHERN NIGERIA

Air photographs have been taken of a large part of Northern Nigeria in the last few years, and maps are being prepared from them by the Survey Department of Northern Nigeria and by the Directorate of Colonial Surveys at Tolworth. In addition unrectified photo-mosaics, called print laydowns, have been prepared of certain parts of the country on scales of about 1 : 125,000 and 1 : 50,000. Some of the print laydowns and maps show remarkable linear patterns, large features which are not easily discernable on single photographs covering a few square miles, but very striking on sheets each covering several hundreds of square miles.

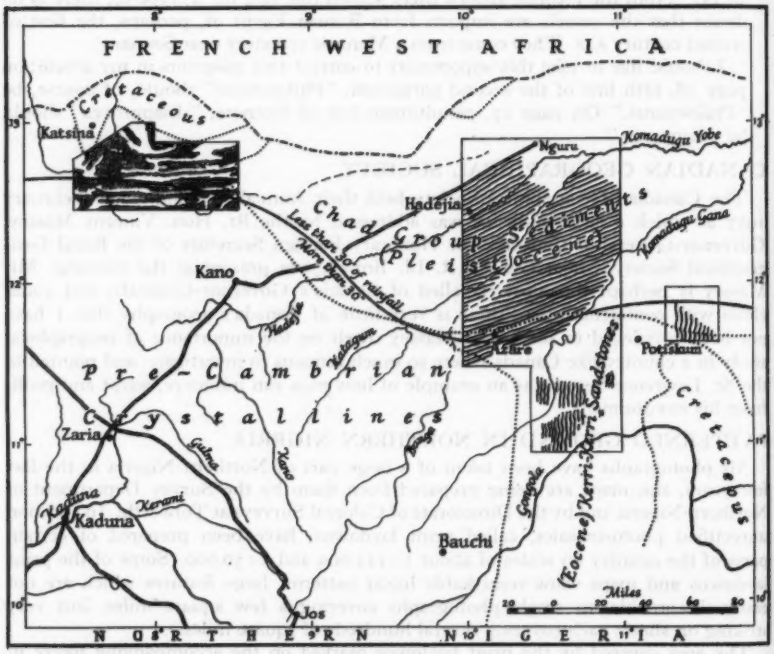
The area covered by the print laydowns marked on the accompanying figure in the Potiskum area extends over about 8000 square miles. They show a large number of parallel stripes, the majority about a quarter of a mile wide but some more than half a mile wide, running straight across country for scores of miles in some cases, and separated by narrower, dark stripes. They are the fossil dunes of the dead erg of northern Hausaland. Falconer describes them as ancient dunes "in the form of low rounded ridges of loose sandy drift, extending approximately east and west, rising in succession upon the level plain and bearing witness to the former prevalence of desert conditions." [1] Raeburn and Brynmor Jones agree with Falconer that the dunes appear to be elongated in a north–south direction in Bornu, while in Katagum they are more east–west.[2] Incidentally, they say that the outline of the dunes has usually been so modified by erosion that it is difficult to determine the original direction. J. W. du Preez states that the dunes in south-west Bornu run 30° south of

[1] Falconer, J. D., 'The geology and geography of Northern Nigeria,' 1911, p. 57.

[2] Raeburn, C., and Brynmor Jones, "The Chad Basin, geology and water supply," *Bull.* 15 *of the Geol. Surv. Nigeria*, 1934.

west and notes that there are minor undulations in the landscape with cross-dunes that run transversely against the more prominent dunes.[1] Some dunes of this latter type can be detected on the photographs; the majority are parabolic in plan, and convex to the WSW.

The lines on the accompanying figure do not represent actual dune-lines, but show their general run in a direction 062° near the railway to Nguru, swinging round to 072° in the south near Azare. Much of the area is farmed, with cropped fields on the low dune ridges and the intervening marshy hollows left uncultivated. The mean annual rainfall at the present day is between 25 and 30 inches. Much remains to be learned about the way in which such dunes form but it is reasonable to assume that



the rainfall would need to be less than about 5 inches. At the present time the nearest large mobile dunes seem to be in about lat. 16° N. where the rainfall is less than 200 millimetres. It may be concluded that at some stage of the Pleistocene the margin of the desert lay at least 4° or 5° further south than at present and, with less certainty, that the prevailing winds were from the ENE. The run of the dunes corresponds with the direction of sand movement in the southern Sahara at the present day, as determined by Dubief from records of wind velocities and employing a formula derived from Bagnold's classic work.[2] The present rivers flow down the gentle slope towards Lake Chad in the north-east. The larger ones have cut wide shallow valleys across the dune system, and their meandering channels are flanked by numerous

[1] du Preez, J. W., Groundnut Scheme, Bornu; Water Supply, Annual Report of the Geological Survey of Nigeria for 1947, p. 29.

[2] Dubief, J., "Le vent et le deplacement du sable au Sahara," *Trav. Inst. Rech. Sahariennes*, 8 (1952), p. 156.

ox-bow lakes and old river-bank deposits. The courses of the smaller streams are largely controlled by the run of the dunes, and over wide areas the direction of drainage is very indeterminate.

The ENE.–WSW. system of dunes overlies unconsolidated Pleistocene and Pliocene sedimentaries of the Chad Group, and extends south for a few miles over the Kerri-Kerri Sandstones, which are probably of Eocene age. Print laydowns covering areas east and south-west of Potiskum show that the longitudinal dunes are bordered on the south side by a somewhat irregular pattern of large-scale ripples, mainly over the Kerri-Kerri Sandstones, running approximately from north to south, and with a wave-length of a few hundreds of yards. The vegetated hollows drain into shallow tributary valleys of the larger rivers, but the regularity of their pattern suggests that wind action has been primarily responsible for their formation. These might be the north–south dunes described by Falconer, Raeburn and Jones. Transverse dunes have been described by Urvoy on the margins of the dead Manga erg, which lies between Zinder and Lake Chad and may be a continuation of the Hausaland erg.[1] A more complete study of the photographs is required to reveal the dune pattern in its entirety before any sound conclusions can be reached as to their nature. Field investigations would also be necessary, but it must be emphasized that these features are often not easily discernable on the ground.

About 150 miles to the west, between Kano and Katsina, another large area of patterned ground occurs, the origin of which is more obscure. In 1952, when I was making a land use survey of Bindawa district covering about 150 square miles about 20–40 miles south-east of Katsina town, I found some indications that the cultivated and uncultivated land is arranged in broad strips running east to west. But the context of this relatively small area only became apparent when the larger pattern was revealed in the 1 : 100,000 sheets of Kazaure and Katsina, published by the Directorate of Colonial Surveys in 1955. These maps, based on air photographs, show cultivated land shaded grey and the uncultivated land left in white. The arrangement is more complicated than the one shown on this reduction but the linear pattern is unmistakable. From the 1952 survey of land use it was clear that the farmland is mainly on deep sandy soils, while the land left for communal grazing is underlain by hardpan (lateritic ironstone) at a depth of a few inches. The land use and soil pattern are closely related because this is a heavily settled region where the cultivable land is cropped nearly every year, and the poorer land is overgrazed and impoverished, and on the whole unfit for cultivation. The relief is greater than in the erg of the Hadeija area described above. The strips of ironstone occupy the higher ground near Bindawa while the sands lie on gentle slopes and valley floors. In some places the sands are underlain by lateritic ironstone, apparently formed in the coarse drift and weathered material overlying the crystallines; in others the sands are separated from weathering crystalline rocks by a foot or two of coarse ironstone and quartz gravels. On the 1 : 100,000 maps the uncultivated land appears mainly along the east–west interfluves; the strips left unshaded in the accompanying figure. An explanation of this pattern has, so far as I know, still to be given. The area is underlain almost entirely by granites and gneisses with some quartzites, and there is a faint possibility that the patterns are controlled by structures in the crystallines. On the other hand, the general run of the stripes, in a direction slightly north of east, suggests the possibility of past wind action again having been responsible.

Air photographs of Northern Nigeria show many other patterns for which I have found no entirely satisfactory explanations. For example, there are sets of curved lines on photographs of parts of the Benue Valley underlain by Cretaceous sandstones that have variously been attributed to cattle tracks, burn marks, and surface indications of false-bedding in the sandstones. Again, I have noticed that field-patterns in the Muslim areas of Nigeria are markedly rectangular, with boundaries running more or less north–south and east–west, clearly enough to allow one to orientate the

[1] Urvoy, Y., "Les formes dunaires a l'ouest du Tchad," *Ann. de Geog.*, 42 (1933), p. 510.

photographs in many cases. There are other features that could be mentioned, but it is hoped that sufficient has been said in this note to call attention to some of the problems and opportunities the new maps and photographs offer. A. T. GROVE

THE IGU NEWSLETTER

The International Geographical Union is continuing the publication of its *Newsletter* without the financial support it formerly received from UNESCO. The format has been retained, though it has been necessary to reduce the number of pages, and only in special cases will the text be printed both in English and in French. The *Newsletter*, edited by the Secretary-Treasurer of the Union, Professor Hans Boesch, will be published twice a year, in January and July. The current issue (January 1957) includes notes on the Regional Conference in Japan, 1957, recent geographical developments in China, and a list of the Commissions with their members.

Geographers and institutions in countries which are members of the I.G.U. can obtain their copy free of charge from their National Committee of Geography. Requests from other countries should be sent to the Secretariat of the I.G.U., Geographisches Institut der Universität, Freistrasse 30, Zürich, 32, Switzerland, whence it will be mailed directly at the subscription rate of $4.0 for the period 1957–60.

THE IRISH IN GREAT BRITAIN

At no time has the emigration rate been a matter of greater concern in Ireland. The heavy movement to Britain during the 1939–45 war has been continued since though the expectation of considerable movement to America has hardly been realized. Between 1951 and 1956, the net emigration from the Republic of over 200,000 people caused a population decline from 2,961,000 to 2,895,000 (−2·2 per cent.) in spite of the highest natural increase since 1951 (135,000, +4·6 per cent.). Phrases like "the vanishing Irish" have already become serviceable titles for publicists, but it is clear that regeneration continues. There is no inevitable correlation between a high rate of outward movement and poverty of natural resources, for many parts of the west of Ireland have had lower rates of emigration than much richer areas in the Central Lowland. For 1956, however, the county figures show high rates of movement from the Connaught province and from Co. Donegal, all of which are relatively poor, but also from the counties of Cavan and Monaghan, neither of which is in general poverty-stricken. A far deeper study of the incidence of movement is needed before one accepts tempting correlations and so far only county figures are available for 1956. From the six counties of Northern Ireland emigration is considerable, though no 1956 Census was held: the problem there is an unemployment rate higher than that in any area of Britain, now being met partly by the introduction of new industries as in the British development areas.

Irish emigration to Britain probably began two centuries ago, and was well established by the early nineteenth century. And it has at all times been primarily a movement of people from the countryside into towns, especially into large towns, though the movement of harvesters is long-established, especially to Scotland. In 1841, four-fifths of all the Irish-born in England and nearly three-fifths of those in Scotland were in towns of at least 10,000 people, and many of the rest were in industrial areas excluded by this statistical limit. Nor was the position different in 1951, when 68 per cent. of the Irish-born in Britain were in towns of 50,000 people or more and many of the remainder in smaller towns. By 1841 there were strongly established Irish communities in some of the major industrial areas of Britain: at this time the Irish-born in Scotland numbered 126,000, 4·8 per cent. of the entire population. Glasgow, and some of its industrial neighbours such as Airdrie, Greenock and Paisley, all had at least 10 per cent. of their population born in Ireland, and the neighbouring counties had received large numbers of emigrants: the proportion born in Ireland was 11 per cent. in Dunbarton, 13 per cent. in Lanark, 13 per cent. in Renfrew, and 15 per cent. in Wigtown, this largely a settlement of farm labourers.

Scotland still attracts Irish immigrants, but in 1951 the number of first-generation migrants was only 89,007, 1·7 per cent. of the population. Some 34,500 of these were in Glasgow and another 25,000 in the neighbouring counties of Dunbarton, Lanark and Renfrew. Other Scottish cities have never had a large Irish influx: at the 1951 Census the number of Irish-born in Edinburgh was 5400 (1·1 per cent. of the population), in Dundee 1100 (0·6 per cent.) and in Aberdeen 600 (0·3 per cent.). There is a general tendency for the immigrants to go where others have gone before them, provided that work is available: the first-generation immigrants to Glasgow represent 3·2 per cent. and the 2600 Irish in Clydebank 5·7 per cent. of the whole population. In one interesting respect the movement to Scotland differs from that to England and Wales, for only half the migrants to Scotland come from the Republic, compared with threequarters in England. In Glasgow, for example, 49 per cent. of the Irish-born were from Northern Ireland, in Clydebank 57 per cent. and in the counties of Lanark and Renfrew 60 per cent.

England in 1951 had 608,000 Irish-born people, 1·5 per cent. of the whole population, compared with 284,000 first-generation migrants, 1·9 per cent. of the whole, in 1841. Before the Famine, the main Irish communities were in Manchester and Liverpool, in both of which they numbered more than one-tenth of the population, and also in London, where some central parishes such as St. Giles-in-the-Fields (Holborn), Shadwell and Whitechapel, had a similarly high proportion. In 1951, there were 111,700 Irish-born people within the county of London (3·3 per cent. of the whole), but they numbered at least 5 per cent. in nine central boroughs, Chelsea, Hammersmith, Hampstead, Holborn, Kensington (6·3 per cent.), Paddington (8·4 per cent.), St. Marylebone, St. Pancras (6 per cent.), Westminster (6·8 per cent.), and the 256 Irish-born represented 4·8 per cent. of the small population of the City of London. Liverpool (17,900, 2·8 per cent.) and Manchester (19,800, 2·3 per cent.) still attract the Irish, but a far greater attraction is seen in the figures for Birmingham (36,300, 3·3 per cent.) and Coventry (10,000, 4 per cent.). Well over half the recent immigrants are living either in the west Midlands (some 50,000) or in London and its surroundings, which has over a quarter-of-a-million; that is, within the parts of England where industrial expansion has been most marked in recent decades.

Wales never attracted large Irish communities. In 1841, there were only 5300 Irish-born, 0·6 per cent. of the total population, within the Principality, which in 1951 had 18,700 first-generation settlers, 0·7 per cent., of whom 10,400 were in Glamorgan and Monmouth. Various historical studies of the modern Welsh industrialization suggest that immigrants were drawn from rural areas and that in the mining areas the high natural increase replenished the working strength so that there were few jobs for outsiders. And for thirty years the coalfields have had a declining labour force with some notoriously high rates of unemployment and outward migration.

Irish emigration for several generations was directed mainly overseas, especially to the United States. But in the world economic crisis of the early 1930's a significant change occurred; after a short period when there was no emigration from Ireland, outward movement began again, but almost entirely to Great Britain. After the 1939–45 war it was expected that America would be open once more, but recent statistics show that the overseas movement has been small: in 1955, for example, 5400 went abroad, of whom 3400 went to the U.S.A., 850 to Canada and 530 to Australia. All the efforts to develop home industries, to improve rural amenities, to revitalize farming, to open mines, even to keep people at home by propaganda of various types, have little effect when jobs are available in Britain, at good rates of pay. Now, as for many years, Ireland is a reservoir of labour on which Britain can draw at will, and its Irish community might well be the subject of sociological study.

T. W. FREEMAN

Note.—The material used in this note was drawn from the 'Census of Ireland 1841,' and from recent articles in the *Irish Trade Journal and Statistical Bulletin*, issued

quarterly by the Central Statistics Office, Dublin, vol. 30, 1955, pp. 83–5; vol. 31, 1956, pp. 89–91, 95–8.

SOVIET SERIALS IN THE SOCIETY'S LIBRARY

BULLETIN (IZVESTIA) ACADEMY OF SCIENCES OF THE U.S.S.R. GEOGRAPHICAL SERIES, 1956: No. 6 (November–December). The International Geographical Congress and the contribution of Soviet geographers, by I. P. Gerasimov. Short account of the geomorphology of the Antarctic, by D. G. Panov. New manifestations in the industrial geography of Germany, by M. M. Zhyrmunskii. The Damodar industrial region of India, by F. D. Yaroshenko. Economic regionalisation of Syria, by E. A. Shchukin. Development and distribution of productive resources in the European North (of the U.S.S.R.) in the Sixth Five-year plan, by A. S. Polyakov. History of the formation of the Volga valley from Unja to Kama, by N. A. Bocharov. Investigations of terraces of some rivers in the Baikal mountain region, by A. A. Yatsenko. Earliest printed materials on the First Kamchatka Expedition (1725–1730), by V. I. Grekov. The economic regionalisation of the countries of Peoples' Democracy, by K. Marinov. Present state of geography in Japan, by L. Z. Levin. Soviet work in the Antarctic in 1957, by A. F. Treshnikov. The Second Oceanographic Expedition to the Antarctic of the Academy of Sciences of the U.S.S.R., by I. V. Maksimov.

BULLETIN (IZVESTIA) ALL-UNION GEOGRAPHICAL SOCIETY OF THE U.S.S.R., Vol. 88 (1956), No. 6 (November–December). The geographical zonality of geochemical processes, by K. I. Lukashev. The geographical ideas of Christopher Columbus, by D. Y. Tsukernik. Variations in climate of the Crimea in the historical period, by A. A. Borisov. Life and work of N. A. Bush, the botanist, by L. A. Utkin. Some details of the biography of M. V. Pevtsov, explorer of Central Asia, by S. A. Ogurtsov. Peter the Great's embassy in the Tian-Shan, by B. A. Lunin. New details of the Caspian Sea level at the end of the eighteenth century, by N. K. Kazancheev. Local climate and its effect on agriculture, by A. V. Gembel. L. S. Berg's route in 1912 in the Chernigov Guberniya, by R. L. Zolotnitskaia. The 18th International Geographical Congress, by S. V. Kalesnik.

NOTES

Notice has been received from the University of Indiana of a new "Quarterly Journal of the Humanities, Arts and Sciences," entitled VICTORIAN STUDIES, to begin publication in the autumn of 1957. This quarterly, to which the subscription is to be $5.00 or 35*s* a year, will be devoted to the examination of English culture approximately between the years 1830 and 1914. It will be noticed by geographers that 1830 was the year in which the Royal Geographical Society was founded, and that in the period which followed the achievements and discoveries of travellers and explorers were important features of Victorian culture. Several well-known English humanists are on the advisory board. The General Editor is Philip Appleman, and further information may be obtained from Indiana University, Bloomington, Indiana.

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An attractive catalogue has been published of MAPS AND PLANS OF MANCHESTER AND SALFORD 1650–1843; compiled by J. Lee, and described as a "Handlist," it claims to "list and classify, for the first time, all the published plans of Manchester and Salford from the first reasonably authenticated one, drawn about 1650, to the issue of the first large-scale Ordnance Survey plans in 1843." There were older manuscript plans of Manchester of which the most notable was that by Christopher Saxton who "described and measured" the town in 1596. This has unfortunately not survived. There is, however, an anonymous manuscript plan of 1556. The "Handlist" is published by John Sherratt of Altrincham at 5*s*; it contains an introduction, 65 items in chronological order, and a well-produced plate of John Berry's plan of 1755.

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THE BRITISH COUNCIL, 65, Davies St., W.1, issued earlier this year its useful guide to scholarships offered by foreign universities for study abroad. The grants are for study, at university level, for periods up to a year, in a large number of European countries, and also in Brazil and Persia. France in particular offers a number of opportunities. It is hoped to issue the booklet for 1958/9 rather earlier in the preceeding academic year, because most of the awards have closing dates in March. The present booklet contains a brief section on awards in Commonwealth countries, the United States of America and Israel, and draws attention to the UNESCO handbook 'Study abroad,' obtainable from H.M. Stationery Office at 10*s* 6*d*; and to the list of awards tenable abroad by British graduates obtainable from the Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

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The Department of Mines and Technical Surveys, Ottawa, has announced the appointment of Dr. N. L. NICHOLSON as Director of the Geographical Branch. Dr. Nicholson, who became a Fellow of the Society in 1942, has been Acting Director since the resignation of Professor J. W. Watson, Professor of Geography at Edinburgh University. He joined the Branch in 1949 to head the Section on Canadian Geography and among his new duties will be the supervising of the preparation and publication of the new Atlas of Canada, due to appear in 1958. Dr. Nicholson, whose early education was in England, received his M.SC. degree from Western Ontario University, where he specialized in land use geography, and his PH.D. from the University of Ottawa, after a period studying Arctic geography at McGill under a Carnegie Fellowship.

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OBITUARY

THE RT. HON. THE EARL OF ATHLONE

The Rt. Hon. The Earl of Athlone, K.G., P.C., G.C.B., G.C.M.G., G.C.V.O., D.S.O., F.R.S., Honorary Member of the Society since 1940, died on 16 January 1957. The Earl of Athlone was an enthusiastic traveller, and at the Society's Annual Dinner in 1938 he described his journey home from South Africa in 1930–31 at the termination of his Governor-Generalship. The Earl and Princess Alice visited the Rhodesias, the Belgian Congo, Egypt, Syria, Turkey, and Sau'di Arabia—this being the first British Royal visit to that country.

ADMIRAL RICHARD EVELYN BYRD

1888–1957

The untimely death of Admiral Richard Evelyn Byrd, on 11 March 1957, was a tremendous loss to the people of the entire world. The international press took cognizance, in editorial tribute and in résumés, of a remarkable life spent in rolling back the frontiers of knowledge in geography and the humanities. His leadership, his loyalty to his men, his modesty (which always caused him to pass on to his followers the credit for his achievements), his cold courage, his almost mystical philosophy of life which guided him in hours of extremity, and his demonstrated concern for the welfare of his fellow man, all attest to his greatness.

During the Antarctic winter of 1934, Admiral Byrd chose to survive or die alone at his Bolling Advance Weather Station rather than tap out the SOS signal, because he feared that others would die in an attempt to reach him. Feeling that all was not well with his leader, Dr. Thomas Poulter (second-in-command) determined to investigate, and succeeded in getting through only after two previously unsuccessful attempts. When Poulter, with Demas and Waite as crew, arrived at the Advance Base by tractor on August 10, the Admiral was so weak that they doubted his ability to survive much longer. Many believed that this solitary wintering experience took years from the life expectancy of Admiral Byrd.

The outstanding accomplishments of Admiral Byrd are so well known, especially to readers of this Journal, that only a brief outline is necessary here. Born in Winchester, Virginia, on 25 October 1888, the son of Richard E. and Eleanor Bolling (Flood) Byrd, Richard Evelyn Byrd, Jr., attended Shenandoah Military Academy, Virginia Military Institute, and the University of Virginia prior to entering the United States Naval Academy in 1908. Graduating with the Class of 1912, he was commissioned Ensign to rank from 8 June 1912. He was transferred to the Retired List of the Navy on 15 March 1916, by reason of a leg injury sustained in athletics. Recalled to active duty during the First World War and on subsequent occasions, he was steadily advanced in rank on the Retired List, the last advancement being to the rank of Rear-Admiral by special Act of Congress on 21 December 1929, "in recognition of his extensive scientific investigations and extraordinary aerial explorations of the Antarctic continent, and the first mapping of the South Pole and the polar plateau by air."

A distinguished pioneer in aviation, particularly in the field of aerial navigation, Admiral Byrd both devised navigational instruments and worked out techniques, that helped to make possible the first trans-Atlantic flight in 1919, which were the basis for his own Atlantic crossing in 1927. He will be, however, best remembered as a polar explorer, beginning with the 1925 MacMillan Arctic Expedition on which he commanded the Naval Flying Unit. With this experience as a basis, Byrd and Floyd

Admiral Richard E. Byrd before leaving for Operation Deepfr

Official United States Navy pho

Bennett, the following year, flew from Spitsbergen to the North Pole and back. The climax of the First Byrd Antarctic Expedition (1928–30) was his successful flight over the South Pole. Equally important in the long run was the great amount of scientific work carried out by the expedition and the use of aircraft and motor transport in polar operations. The Second Byrd Antarctic Expedition (1933–5), during which occurred the episode at Bolling Advanced Weather Station, was notable for its intensive scientific work.

Admiral Byrd's first two expeditions were largely instrumental in interesting the United States Government in the Antarctic area, a development signalized by the creation in 1939 of the United States Antarctic Service with Byrd at its head. Although planned to operate for at least a five year period, the Antarctic Service was interrupted by the Second World War. Its single expedition (1939–41) established two bases, East Base on Stonington Island in Marguerite Bay, and West Base (Little America III) in the Bay of Whales, Ross Sea. From both bases extensive exploration was carried on in support of a vigorous scientific programme.

After the conclusion of hostilities, Admiral Byrd once again revived the interest of the United States Government in Antarctica. The first result was Operation High-jump sponsored by the United States Navy, the largest expedition ever sent to the area. Byrd served as Officer-in-Charge, directing the technical work and making his vast experience and knowledge available to the Navy commanders involved.

During the current operations in support of the International Geophysical Year, he was designated Officer-in-Charge, United States Antarctic Programs, by direction of the President. In this capacity, he was the senior representative of his country in Antarctic matters and was charged with responsibility for monitoring the political, scientific, legislative, and operational activities which comprise the total United States Antarctic programme. Another responsibility was the development of legislation to establish a permanent Antarctic unit in the United States Government, and Admiral Byrd devoted much thought and energy to this during the months just before his death.

Characteristic of Admiral Byrd was his devotion to the service of his country and to the welfare of his fellow men both in the United States and in the world. During the Second World War he carried out special missions for which his wide experience had uniquely qualified him. Sincerely devoted to helping the oppressed, he was founder chairman of the Iron Curtain Refugee Campaign of the International Rescue Committee. He took special interest in placing scientists in useful positions in the free world. Finally, by his own activities and by the use of his great prestige, he tried constantly to promote better relations between peoples, and to further world peace. In his speeches and correspondence he took great pride in pointing to the Antarctic as an area where men of many nations forget their quarrels and work together toward the advancement of scientific knowledge for the benefit of all mankind.

RICHARD B. BLACK

COMMANDER J. H. MATHER, D.S.O., V.R.D., R.N.V.R.

Commander Mather, who died on 10 April 1957, was one of Captain Scott's Terra Nova Expedition 1910–13. A member of the crew, he was trained as a taxidermist in New Zealand, and was responsible for skinning all the ship's specimens. He retired from the Navy in 1937 but rejoined in the last war and served on the staff of the Admiral Commanding Western Approaches. Commander Mather will be best remembered as the founder of the Antarctic Club, and as its most enthusiastic Honorary Secretary for twenty-seven years. He knew personally, and kept in touch with, almost every member of British Antarctic expeditions of the last fifty years, and it was due to his untiring labour that many Antarctic explorers have been able to renew annually friendships made many years ago.

A. STEPHENSON

COLONEL H. W. TOBIN

Colonel Harry Walter Tobin, D.S.O., O.B.E., editor of the *Himalayan Journal*, died at his home in Lymington on Tuesday 8 January 1957 at the age of seventy-seven. Commissioned in the Royal Artillery in 1898, he spent most of his service in the Indian Army. He was one of the secretaries of the Royal Central Asian Society and a member of the managing committee of the Everest Foundation.

As a member of the former Mountain Club of India (founded in 1927 by Allsup with Charles Bruce as President) he became a founder member of the Himalayan Club when the two were merged under the latter name. Later he was to become its Vice-president and he has edited the *Himalayan Journal* since 1949. The writer, who met Tobin first in 1927, knows little of his earlier career. In 1920, with Raeburn and Crawford, he explored the Talung Glacier; it is doubtful whether from then until he retired and settled in Darjeeling (in 1927) he found time to expand his interest in the Himalayas. This interest was further stimulated when in 1929 Paul Bauer led his Bavarians in their first attempt on Kangchenjunga. It was Tobin who, on behalf of the Himalayan Club, helped them with their baggage and selection of porters and accompanied them on their first reconnaissance of the Zemu Glacier. On their second attempt in 1931 it was he again who gave them all possible help in Darjeeling and visited them in their advanced base below the east ridge. Thus began a friendship with the Bavarians which endured until his death and has included several visits to Munich and the Dolomites. He always kept himself fit and took part in any activity that offered; characteristically on his retirement at the age of fifty from the command of the 1/4 Bombay Pioneers he joined the volunteers as a trooper in the Northern Bengal Mounted Rifles. His wife died three years before he did and he leaves a married daughter to whom we offer our sympathy. By his death the *Himalayan Journal* loses an energetic editor and a number of us a staunch friend.

E. O. SHERBEARE

SIR BASIL GOULD, C.M.G., C.I.E.

After Winchester and Oxford, "B.J." (as he was known to his friends) joined the Indian Civil Service in 1907 and, after the usual preliminary training in a district, he joined the Indian Political Department in 1909 and was posted to Central India. In 1911 an officer was wanted for the isolated but responsible post of British Trade Agent at Gyantse in Tibet. During his time here he was sent to England with four Tibetan boys whom the Tibetan Government wished to educate in England. The school chosen was Rugby. One of these boys, Kyipup, was working in Lhasa for the Government until recently unless, as is probable, he was considered as tainted with imperialist ideas; I have heard he has now died. "B.J." remained at Gyantse until the outbreak of the First World War. He at once tried to join the forces but, as in so many similar cases, his experience in India and Tibet was too valuable to allow him to leave.

He was posted to the North-West Frontier Province where apart from his official work he became whip to the Peshawar Vale Hunt. He was then appointed Assistant Private Secretary to the Viceroy (Lord Chelmsford). From here he went to Seistan on the Perso–Afghan border as Consul. From Seistan he was transferred to Kashmir but was very soon sent to Kabul as Counsellor under Sir Francis Humphrys. The foreign legations were evacuated when Bacha Saqao turned Amanullah out, and for a short time sat on his throne. The trouble was especially dangerous for the British Legation which was located between the two warring parties. They suffered several casualties and "B.J." received a dose of splinters in his face from a near miss.

After this, for several years (1929–35), he was employed on the North-West Frontier, at that time, as usual, in a state of warlike disturbance. He was severely injured in the great Quetta earthquake and, after a time to recuperate, he returned to Tibet, this time as Political Officer Sikkim, a post which included relations with Bhutan and also

Tibet. Here he was instrumental in getting permission from the Tibetan Government for the Everest Expedition, not a very easy matter. He also arranged for the movement of supplies to China for the war against Japan and was also instrumental in bringing about the *de facto* permanent representation of the Indian Government in Lhasa. Apart from his official work he was successful in introducing trout into the streams and lakes of Sikkim and Bhutan as well as into the Ammo Chu (river) in the Chumbi Valley. He also left his mark on the botanical knowledge of these countries. In cooperation with Hugh Richardson, who was for many years British Agent in Lhasa, he brought out a book on Tibetan in a quite novel approach to this difficult language.

He paid several visits to Lhasa and the culmination of a very long, successful and interesting career was his presence at the installation of the new Dalai Lama, a ceremony at which no European had ever been invited to attend before.

At the time of his death he was on the point of bringing out a book of memoirs which will, it is understood, shortly appear under the title of 'The Jewel in the Lotus.'

He had been a Fellow of the Royal Geographical Society since 1913. He married first Lorraine, daughter of Mr. Kebbel of New Zealand. Of his two sons one was killed in the Second World War. He married secondly Cecily, daughter of Colonel C. H. Brent-Good, of Yarmouth, Isle of Wight, and left one son of this second marriage.

F. M. BAILEY

MEETINGS: SESSION 1956–7

Meeting of 28 January 1957. The President in the Chair

Elections to Fellowship: Rev. R. A. Anderson; W. N. Batten, B.A.; D. S. Biddle, B.A.; G. Bowley, M.A.; Dr. G. J. Butland; J. R. Bryans; L. Callaghan; Miss M. T. Hinds, B.A.; R. E. C. Hogg; Flight Lieutenant H. G. Jones; A. Logan; Mrs. J. H. Lomas; G. V. Lorimer; R. Mabey; C. J. Miller; E. Minos; F. C. Reed; Rev. J. M. Reeves; Professor I. Schapera; J. T. Shaw; F/O R. W. Timms; P. C. S. White; Rev. J. Woodhead; G. P. St. E. Wijeyekoon, B.SC.

Elections to Associate Membership: B. J. R. Blench; Miss S. N. Dixey; R. A. Hinds

Paper: Recent developments in Soviet Central Asia. By Lieutenant-Colonel G. E. Wheeler

Meeting of 4 February 1957. Professor E. H. Thomson in the Chair

Paper: Surveying aneroids: uses and limitations. By B. W. Sparks, Colonel C. A. Biddle and R. A. Hamilton

Meeting of 18 February 1957. The President in the Chair

Elections to Fellowship: J. D. Andrew; D. H. H. Beams; Miss M. E. Blandy; Rev. R. B. Blocher; Mrs. N. Russell-Cobb; A. J. Cookson; G. D. Delafield; Father H. Douglas; Miss K. N. Egan; P. F. Gardner; Mrs. C. S. Grinling; G. Hare, B.A.; M. Sinclair-Hill; R. A. Innes; Miss J. G. Minton; P. Moss; N. O. I. Okwuosa, B.A.; D. J. Quick; J. Snowden; P. B. Thomas; G. M. Turner; Commander E. B. Turtle; M. J. Webb

Elections to Associate Membership: C. J. H. Dodd; K. U. Hanid; Miss G. A. Hunt; Miss J. Puddy

Paper: Crossing the Patagonia ice cap. By H. W. Tilman

Meeting of 25 February 1957. Mr. Leonard Brooks in the Chair

Film: Tristan da Cunha and Gough Island. Commentary by James Hall

Meeting of 4 March 1957. The President in the Chair

Film: New China 1956. Commentary by J. E. B. Hill, M.P.

Meeting of 18 March 1957. The President in the Chair

Elections to Fellowship: Arthur R. Akester; George B. Blaker; J. F. Bye; John C. Charters, M.A.; Raymund E. Cooper; Miss Kathleen E. Drax; Clifford G. Fenner; P. F. Fernando; J. E. Fordham, A.R.I.B.A.; David Grieves, B.SC.; Frank Hillam; Colonel J. V. Davidson-Houston; Major T. E. Hudson; Thomas Johnston; Miss G. B. Keatinge; William Kirby; John R. Macky; Ian M. Matley, M.A.; H. J. A. Millaship; Hans Mock; George H. Phillippo, B.A.; Leslie E. Ranns; James G. D. Simpson; Richard J. D. Smith; Mrs. Constance Wager; T. M. Walters; E. A. Warren

Paper: Exploration in the northernmost Andes. By Allan Cunningham

Meeting of 25 March 1957. Professor J. A. Steers in the Chair

Paper: Geographical aspects of the British Solomon Islands. By J. C. Grover

Meeting of 8 April 1957. The President in the Chair

Elections to Fellowship: Mrs. Constance Adams, B.A.; Rex Barham, B.SC.; Henry H. Beamish; Miss Heather F. Bennett; Bernard H. P. Boddy; Cecil O. Boving; Paul H. Butterfield; H. J. Cartwright; 2nd Lieutenant Arthur Charlesworth; Brian R. Chrimes, B.SC.; Miss C. L. M. Crole; Sydney Daniel; Miss Violet Dann, B.SC.; Frances M. Downer, B.A.; Major-General Sir Maurice Dowse, K.C.V.O., C.B., C.B.E.; The Hon. Mrs. Charles Fortescue; Alfred C. Gladitz; John Edwin Green; Mrs. Violet Hannan; Commander Robert F. Harland, R.N.(rtd.); John E. P. Heath; Maurice A. Hill; Herbert W. Holroyd; Mrs. J. McGown Kennedy; Kenneth Clifford Lovell; Raymond MacNamara, M.A.; James A. Majasan; James H. Meester; F. J. Montero; Miss M. A. Morgan, B.A.; Philip Oliver; Arthur K. Patterson; Miss Celie M. Peters; Lieutenant-Colonel Henry M. Shellard, M.B.E.; David L. Snellgrove, M.A., PH.D.; John D. A. Stainton; William Townson; William Wallace; W. St. John White; Roger S. Wickens; Miss Barbara C. H. Wilde, B.A.; Leonard Wolfson

Elections to Associate Membership: Miss Judith Burgess; Colin M. Danby; J. Gestetner; David E. Press

Paper: Exploration of Huagaruncho. By John Kempe, George Band and Michael Westmacott

Meeting of 15 April 1957. Mr. Leonard Brooks in the Chair

Film: Song of the clouds. Introduced by Sir Arthur Elton and John Armstrong

Meeting of 24 April 1957

Paper: Tellurometer system of distance measurement. By T. L. Wadley